SCIENCE ABSTRACTS.

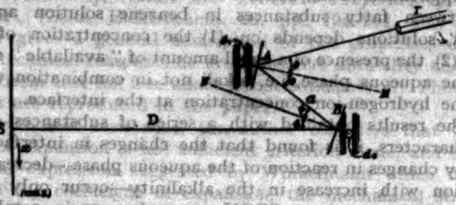
Section A.—PHYSICS.

NOVEMBER 1922.

GENERAL PHYSICS.

2179. *Determination of Periodic Errors of Micrometer Screws.* **R. Mecke.** (Zeits. Instrumentenk. 42. pp. 147–151, May, 1922.)—The method employed makes use of a scale divided into fractional parts of a millimetre, such scale having only periodic errors. It is shown how the determination of these periodic errors, using a micrometer screw, leads to a simple method for estimating the periodic errors for other parts of the screw than that originally used. For details of the method the original paper should be consulted. A. W.

2180. *Small Roller Extensometer.* **E. H. Lamb.** (Engineering, 113, p. 684, June 2, 1922.)—Describes a small, light and simple form of extensometer of which the principle will be clear from the figure. A and B are two mirrors rigidly attached to the small rollers d_1 and d_2 which make contact one on either side of the test piece. The light from T is reflected at A and B to a scale S. If d be the common diameter of the rollers and AB $= a$, then the extension $e = dx/4(\mathrm{D} + \frac{1}{2}a)$ where x is the deflection observed. With values $\mathrm{D} + \frac{1}{2}a = 162\cdot5$ cms. and $d = 0\cdot065$ ins., 1 mm. deflection represents 10^{-5} ins. J. W. T. W.



2181. *Interference Methods for Standardising and Testing Precision Gauge Blocks.* **C. G. Peters** and **H. S. Boyd.** (Bureau of Standards, Bull. 17. pp. 697–713 [Sci. Papers, No. 436], 1922.)—Interference methods are described by which the planeness and parallelism errors of precision surfaces can be measured and the length of standard gauges determined by direct comparison with the standard light waves with an uncertainty of not more than a few millionths of an inch. The errors of other gauges can be determined by comparison with these calibrated standards with equal precision. W. R. C.

2182. *Solutions of the Torsion Problem.* **C. Weber.** (Zeits. Math. u. Mechanik, 2. pp. 299–302, Aug., 1922.)—Supplements Pöschl's paper [Abs. 703 (1922)] by approximate solutions for rods that can be considered as made up of thin strips, particularly when the section is not simply connected. W. G. B.

2183. *Variation of Surface Tension of Mercury in Gases.* **J. G. Popesco.** (Comptes Rendus, 175. pp. 148–149, July 17, 1922.)—A cinematograph apparatus was used to illustrate this fact. A wheel 60 cm. in diameter was put in motion with a linear speed of 6 cm. per sec. by a small electric motor. A revolving shutter, actuated by the same motor, gave an exposure of 1/3000 sec. An image of a drop of mercury, natural size, was obtained as a white mark on a black background, and marked with a small black point. The mercury employed in these experiments was put in a glass vessel placed slightly higher than the steel block on which the drop was formed. The value at the end of five seconds was taken at each experiment, as well as the initial value, and a table giving the results is appended. T. C. H.

2184. *Interfacial Tension and Hydrogen-Ion Concentration.* **H. Hartridge** and **R. A. Peters.** (Roy. Soc., Proc. 101. pp. 348–367, July 1, 1922.)—Comparison of the capillary height, drop weight, and a modification of the ripple method of measuring interfacial tension shows that the drop-weight method is valid for comparing the interfacial tensions of oils or fatty acids against aqueous solutions of various reactions. Application of this method shows that the decrease in interfacial tension between fatty substances in benzene solution and aqueous "buffered" solutions depends on (1) the concentration of the fatty substance, (2) the presence of a small amount of "available" monovalent alkali in the aqueous phase, i.e. alkali not in combination with strong acid, (3) the hydrogen-ion concentration at the interface.

From the results obtained with a series of substances of different chemical characters, it is found that the changes in interfacial tension produced by changes in reaction of the aqueous phase—decrease in interfacial tension with increase in the alkalinity—occur only with those substances which contain a COOH group free or in combination as glyceride. T. H. P.

2185. *Viscosity of Air in a Transverse Electric Field.* **S. Ray.** (Phil. Mag., 43. pp. 1129–1130, June, 1922.)—A transpiration experiment is described showing that the viscosity of air is not altered by as much as 0·3 % due to a transverse electric field in which the potential gradient is about 18,000 volts per cm. J. S. G. T.

2186. *Automatic Multiplying Machine.* **A. Séguin.** (Comptes Rendes, 174. pp. 1154–1157, May 1, 1922.)—Let $a_1, a_2 \ldots a_n$ and $b_1, b_2 \ldots b_n$ represent the digits, in order, of two numbers to be multiplied together. Reverse the order of one series, say the a's. Beneath it place the second series so that b_1 is vertically below a_1, and shift the b series the breadth of a digit to the left, repeating the operation until b_n stands vertically below a_n. At each step, form the products of each pair of digits in the same vertical line, and add the results. Finally add all the terms so obtained. It will be seen immediately that the result is the product

required. The machine automatically effects these operations in succession, once the two numbers are set, and presents the product.
G. W. DE T.

2187. *The Structure of Abraded Glass Surfaces.* **F. W. Preston.** (Optical Soc., Trans. 23. 3. pp. 141–164, 1922.)—Observations are recorded on the tooling of hard brittle substances where the phenomena may be expected to be simplest. The primary object is to substitute the conception of a flaw- or fissure-complex for the current view of a hill-and-hollow structure. The enhanced solubility of ground surfaces in hydrofluoric acid is shown, and the author suggests a value for the upper limit of the thickness of the flowed, or surface tension, layer on polished glass. Mechanical abrasion is shown to be still active during polishing.
W. R. C.

2188. *The Stress Conditions Surrounding a Diamond Cut in Glass.* **A. J. Dalladay** and **F. Twyman.** (Optical Soc., Trans. 23. 3. pp. 165–169, 1922.)—The stressed glass is examined by means of polarised light and conclusions are drawn as to the character of the stresses in the body of the glass.
W. R. C.

2189. *Some Measurements of the Stresses Produced at the Surfaces of Glass by Grinding with Loose Abrasives.* **A. J. Dalladay.** (Optical Soc., Trans. 23. 3. pp. 170–172; Disc., 172–174, 1922.)

2190. *Constants of Nature and Technical Properties of Glass.* **E. Zschimmer.** (Zeits. Elektrochem. 28. pp. 194–201, May 1, 1922.)—The author gives a general description of the properties desirable in glasses for technical reasons: he first considers durability and concludes that the iodesin test for free alkali is not satisfactory. Photographs of faulty glass are reproduced in the paper.

As regards heat resistance, the author considers that the cubical coefficient of expansion is not sufficient criterion alone, and he refers to an empirical expression suggested by Winkelmann which involves, in addition to the coefficient of expansion, the mechanical strength, the heat conductivity, the modulus of elasticity, the specific heat and the specific gravity of the glass.

In the realm of geometrical objects what is desired is a range of glasses covering the widest possible region, both as regards refractive index and mean dispersion. Progress so far has only resulted in the production of glasses of higher dispersion for the same refractive index or higher refractive index for the same dispersion. Glasses combining lower dispersion with the lower refractive index are to be desired. J. W. T. W.

2191. *Correction of Errors in the Balance.* **A. E. Conrady.** (Roy. Soc., Proc. 101. pp. 211–224, June 1, 1922.)—Describes a lengthened study of the causes of errors in a balance of ordinary construction, and of the simplest and most effective methods of overcoming these. The intermediate joint between the scale-pan and the suspension on the knife-edge at the end of the beam is first considered. It is found that when this intermediate joint consists of a pin resting in holes of about double its own diameter, the friction between the pin and the hole is sufficient to enable it to take up any position, less than the sliding angle of friction, from the true lowest point of the hole. There is a consequent uncertainty which may be eliminated by designing the intermediate joint so that its fulcrum takes up a definite position whatever the tilt of the pan.

A second source of error is due to the loading of the knife-edges above the point at which elastic fatigue begins to operate, so that the extra flattening of the edge produced on loading only disappears at a finite time after release. This error is overcome by arranging a sequence of four weighings in such an order that the bias introduced is on one side of the equation in two cases, and on the other side in the remaining two cases.

The author advocates the use of riders provided due care be taken to ensure their exact positioning. He shows that for the accuracy actually attained by means of the precautions and modifications above described, viz. 7×10^{-9} of the load on the terminal knife-edges, the contact lines of the central and the terminal knife-edges must be exact within 1·8 and 5 Ångstrom units respectively, with a lever length of 70 mm. Other imperfections in the performance of balances, such as sticking to the arrestment, sudden shifts due to lack of absolute immovability of the central knife-edges in the beam, etc., are also studied. In the case of balances which are not mounted on immovable supports, the author shows that a tilt of the base plate produces no effect on the results of a weighing if the weights are so adjusted that the centre of gravity of beam and weights lies in the line of the central knife-edge. This he terms the autostatic state of the balance. J. W. T. W.

2192. *Pocket Gyroscopic Level.* (Rev. d'Optique, 1. pp. 287–289, June, 1922.)—A description of a pocket level made by J. Prédhumeau on the gyroscopic principle with which levels may be observed rapidly with a precision of a centimetre when reading at 30 metres. No tripod is needed, but the level may be hung from a single staff. A sectional elevation and plan of the apparatus are given. E. H. B.

2193. *A Field Telemeter for Approximate Surveying.* **I. C. Gardner.** (Optical Soc. America, J. 6. pp. 489–493, July, 1922.)—For filling in the details of a survey a self-contained base range finder would be very useful, but would be expensive, and would require an additional man to carry it. A light portable device has been designed, consisting of two small telescopes, each mounted on a base, and with a slow motion screw permitting a limited motion in azimuth. The two telescopes are clamped, one at each end of a stadia rod, and the whole forms a simple range finder, and enables short distances to be measured with sufficient accuracy. One of the telescopes has a fixed crosswise, and the whole apparatus is swung round until this coincides with the object to be measured; the crosswise of the other telescope is then moved by means of its micrometer screw, until it also coincides with the object; and in this way the angle between the two rays from the object to the two telescopes is determined, a table computed in advance giving the range in terms of the reading of the micrometer screw. To adjust the telescopes parallel in the first instance two penta prisms are placed one in front of each telescope, so that they transmit light to the lower half of each objective. On the outer face of each prism is cemented a lens, the focal length of which is equal to the distance between the two telescopes. Each lens bears a vertical mark and each of these marks will be seen coincident with the crosswise of the other telescope when the two lines of sight are parallel, if the sum of the deviations of the two penta prisms is 180°. With careful work, under favourable conditions, the error of angular measurement may be kept under thirty seconds; making the possible error 13′ at a range of 1000′ and 211′ at 4000′. H. N. A.

2194. *Holweck Molecular Pump.* (Rev. d'Optique, 1. pp. 274–280, June, 1922.)—This pump by Holweck (made by C. Beaudoin) is on the principle of the Gaede pump, but offers the same advantages with a greater simplicity of construction and working. It has no oil inside and works silently. The article includes an exterior view and a sectional diagram by which the working is explained. E. H. B.

2195. *Theory of Dimensions.* **J. Wallot.** (Zeits. f. Physik, 10. 5. pp. 329–348, 1922.)—A mathematical and logical discussion of the theory of dimensions of physical quantities and their units and equational relations. E. H. B.

2196. *Theory of Strains in Quickly-Cooled Substances.* **G. Masing.** (Zeits. techn. Physik, 3. 5. pp. 167–173, 1922.)—Theory is given relative to the strains set up in a quickly-cooled sphere. It is shown that Salpeter's assumption that the plastic deformations involved are purely variations in density is not correct [see Abs. 1359 (1920)]. It is shown also to be possible to calculate the deformations for a sphere exclusively from the final strains, as Salpeter has shown in a different way. A. W.

2197. *Behaviour of Water Film on Glass under the Influence of Electrons.* **M. Pirani.** (Zeits. f. Physik, 9. 5. pp. 327–331, 1922.)—A number of simple experiments with an incandescent light bulb are described, the tungsten filament serving as an electron source. The results obtained are in agreement with those of Langmuir, Campbell [Abs. 510, 1459, 1814 (1921)] and others. A. W.

2198. *Internal Ballistics.* **E. Bollé.** (Zeits. techn. Physik, 3. 6. pp. 205–209, 1922.)—Discusses the problems of ascertaining the gas pressures in a gun and their changes on firing. A special apparatus is shown by a photographic reproduction and tables of results given and analysed. The work was interrupted by the outbreak of war and no opportunity has yet occurred for its resumption. E. H. B.

2199. *Hardness Tests.* **G. Moreau.** (Rev. Gén. d'Él. 11. pp. 106–111, July 22, 1922.)—A slight amplification of a paper published by the author in Annales de Physique. [See Abs. 1222 (1922).] J. L. H.

2200. *On the Decay of Vortices in a Viscous Fluid.* **K. Terazawa.** (Japanese Journal of Physics, 1. No. 2. [19 pp.] 1922.)—The rate and mode of decay of vortex motion in a viscous fluid, in the special case when the vortex lines are straight, and parallel to an axis about which the distribution of vorticity is symmetrical, are investigated. The paper is mainly mathematical, and not easily abstracted. One result that emerges is that if initially the vorticity is concentrated in the vicinity of the axis, there is a marked tendency toward the spreading of the vorticity, before decay is noticeable. The paper contains graphs of the results, and some numerical examples. W. G. B.

2201. *Instruments for Viscosity Research.* **J. Andrade.** (Comptes Rendus, 174. pp. 1519–1523, June 12, 1922.)—This is a preliminary account, setting forth the principles which have guided the author in his development of improved apparatus for viscosity research. He first considers the five principal types of damped vibrations which remain isochronous in virtue of a pendular force and various types of simple resistance; also the three types of mechanism by which the vibrations may be maintained, conserving the isochronism. Each of these types is directly applicable to a fixed chronometer. He considers that his experiments, so far, justify the conclusion that, by means of spiral balance springs, and their oscillations, simultaneously recorded photographically and chronometically, an answer will be obtained to the question: Do the passive viscous resistances reduce to a simple resistance, or is the latter supplemented by a frictional resistance analogous to the sliding friction between solids? If the latter be the case, then the same instrument, suitably arranged, will give the laws of this supplementary viscous friction. G. W. de T.

2202. *The Emission of Light by the Atom.* **K. Försterling.** (Zeits. f. Physik, 10. 6. pp. 387–392, 1922.)—Sommerfeld has suggested that the coupling of the atom to the ether is not of a differential nature, but is integral; that is to say, that the energy is transferred to the ether by the atom in a single "impulse"; and the ether proceeds to distribute it in the form of waves (Atombau und Spectrallinien, 3. Auflage, S. 324). Mie, on the other hand, holds to the differential nature of the coupling [Abs. 902 (1922)]. The author shows that, if Sommerfeld's views are correct, it is necessary to suppose that the energy centre of the radiation is projected from the atom with a certain velocity, and that the atom receives a velocity in the opposite direction; but that these velocities cannot be large, since otherwise a self-luminous body would appear in a different position to that of the same body when externally illuminated. Since Lummer and Gehrcke have found that a wave train remains "coherent" during 2·5 million periods, it follows that, during this time, the energy centre can only have moved a very small distance, say 0·01 mm. No direct action of a magnetic or electric field on radiation in free ether has been observed, and in all theories of the Zeeman or Stark effects the field is assumed to influence the electrons, and not the free ether. If, then, the electrons enter the field after they have given up their energy to the ether, it will not be possible to observe any effect of the field on the radiation from the energy centres in the ether. The experiments of W. Wien, on positive rays, indicate that the hydrogen atom travels at least 1·5 mm. during the period in which light coming from it is emitted; and this distance may be considerably greater, as Lummer and Gehrcke's number for the coherent vibrations is a lower limit, and from their method of observation it follows that after 2·5 million vibrations the intensity has only slightly diminished. If a bundle of positive rays, in a high vacuum, could be passed between two condenser plates a very short distance apart, the light from those atoms which had passed from the outer to the inner quantum orbit, if it had passed from the atom to an energy centre in the ether, which was sending it out in the form of waves, would not show the Stark effect. Thus the unresolved line should be visible for a certain distance inside the field, until the emission of such atoms had died away, or at least for 1·5 mm.; for the energy centre cannot be more than 0·01 mm. away from the atom when the latter has moved 1·5 mm. Preparations are being made to carry out this experiment, but it is possible to deduce from Stark's experiments that, under such circumstances, the unresolved line is not visible, since, if the theory of the "impulse" transfer of energy from the atom to an energy centre in the ether were correct, Stark would have seen the unresolved line in the electric field in his experiments. There are, however, mathematical difficulties in the theory that the electron gives up its energy continuously to the ether, during its passage from its first orbit to its final orbit. When certain assumptions of the quantum theory, which are required to explain the Zeeman effect, are taken into account, it is shown that it is necessary that ν, the vibration frequency of the emitted light, should be equal to or less than the angular velocity ω of the electron in its orbit. In Bohr's atomic model, however, ν at the commencement is greater than ω; it seems necessary to assume that some new form of energy exists in the atom, in order to get over this difficulty. H. N. A.

2203. *The Ratio of the Two Elementary Charges.* **F. W. Loomis.** (Phys. Rev. 20. pp. 15–17, July, 1922.)—The present paper contains a discussion of the exactness of the relation between the charges on the electron and proton. From Aston's measurements with positive rays, the magnitude of the proton charge is found to be equal to that of the electron within an accuracy of 1 %; which is sufficient to establish that the number of protons in a neutral atom is equal to the number of electrons, including those in the nucleus. Much of the most precise value of this ratio, however, can be deduced from Millikan's oil-drop experiments. Since the oil drops in the latter were exactly neutral, ± a small integral number of electronic charges, to 1/1000 of an electron, and since they contained as many as 4×10^{14} protons and nearly the same number of electrons, it follows that the magnitudes of the charges on protons and electrons are equal to one part in 4×10^{17}. These experiments may also be considered a precise confirmation of the relativity law of the invariance of electric charge. The exactness of the simple relation between protons and electrons, appears to the author to be convincing evidence of an underlying unity. The precision of Millikan's measurements, however, is not enough to detect the excess gravitational force (gravitation being attributed to a slight excess in the attraction between charges of opposite sign over the repulsion between charges of the same sign). The effect to be expected is essentially the gravitational attraction between the oil drop and the electrons which are driven around from one condenser plate to the other when the electric field is put on, and this is quite beyond the range of Millikan's measurements, which would have to be accurate to one part in 10^{40} to show it. H. H. Ho.

2204. *Radiation from a Group of Electrons.* **L. Page.** (Phys. Rev. 20. pp. 18–25, July, 1922.)—Classical electrodynamics requires an irreversible radiation of energy from a solitary electron whenever it is accelerated. If, however, a number of electrons at distances from one another, small compared with the wave-length emitted, are accelerated, the radiations from the individual electrons may interfere in such a way as to annul the first order radiation from the group. This is the case when two or more evenly spaced electrons revolve in a single circular orbit. When the velocities of the electrons are high, however, the radiation of lowest order which does not vanish may be quite comparable with the first order radiation which would be emitted if all the electrons save one are removed. The paper, therefore, contains an investigation of the higher order radiation from a group of electrons as required by the classical electrodynamics. The general equation for the intensity is obtained from the field equations of classical electrodynamics by expanding the retarded expression for the intensity due to a point charge:

$$E = \frac{1}{4\pi RC^2}\left[\left\{\frac{d}{dt}(\Sigma ev) + \frac{1}{C}\frac{d^2}{dt^2}(\Sigma er \,.\, Mv) \;.\;.\;.\right.\right.$$
$$\left.\left. + \frac{1}{(n-1)!C^{n-1}}\frac{d^n}{dt^n}(\Sigma er \,.\, M^{n-1}v) + \;.\;.\;.\right\} \times M\right] \times M,$$

where R is the distance from a fixed point in the group, r is the position vector of each electron, v its velocity, and M a unit vector in the direction of R. The Poynting flux is CE^2. The terms in the series correspond to successive orders of radiation. The general condition for the absence of the nth order of radiation is $\Sigma er \,.\, M^{n-1}v$ a constant. For a ring of evenly spaced electrons, the radiation of all orders less than k, the number of electrons, vanishes; but the radiation of order k does not. In fact, $R_k = C_k\beta^{2(k-1)}R_1$, where β is the speed relative to that of light and C_k a constant which increases rapidly with k, so that for most atoms the higher order radiation from a ring with a number of electrons should be even greater than the radiation from the single electron of the hydrogen atom. Only in the case of a continuous distribution of electricity along the ring do all orders vanish. Emphasis is laid on the inconsistency between Bohr's theory of the atom and classical electrodynamics. In the case of the hydrogen or ionised helium atom, where the theory has been most successful, Bohr requires the single electron to revolve about the nucleus in a circular or elliptical orbit without radiating. Electrodynamics, on the other hand, allows no possibility of orbital motion of a solitary electron without radiation. Even in the case of a number of electrons following one another around the same orbit, the higher order radiation emitted should be greater, in the case of most atoms, than the first order radiation from hydrogen. Now the radiation of energy specified by the Poynting vector is one of the most fundamental properties of classical electrodynamics. Hence it is difficult to see how electrodynamics and Bohr's theory of the atom can ever find a common ground. Even the rotation of an asymmetrical positive nucleus would not neutralise the radiation from the hydrogen electron. Therefore, the advisability of seeking some other interpretation of the numerical relationships established by the theory is suggested. H. H. Ho.

2205. *Confirmation of Werner's Theory of Coordination by Means of X-Ray Analysis.* **P. Scherrer** and **P. Stoll.** (Arch. des Sciences, 4. pp. 232–234, May–June, 1922. Paper read before the Soc. Suisse de Physique, Fribourg, 1922.)—Although all the facts of organic chemistry can be represented in a convincing manner by taking as a basis the tetravalent carbon atom, the conditions of valency are more complicated in the case of inorganic compounds. It is not possible to obtain a satisfactory picture of the structure of these compounds by attributing to the elements a fixed number or a maximum number of valencies. Werner has studied the question of valency by introducing the idea of auxiliary valency and the number of coordination which is required in the case of *ammoniacal cells of cobalt* ($CoCl_3$ can unite with 6 molecules of NH_3 to form $CoCl_3(NH_3)_6$).

The authors have studied by means of X-rays the atomic structure of such complex combinations, and have found that the 6 positions of coordination were arranged at the apices of an octahedron. A. B. W.

2206. *Spectra of X-Rays and Theory of Atomic Structure.* **D. Coster.** (Phil. Mag. 43. pp. 1070–1107, June, 1922.)—The object of this paper was to compare the changes in the characteristic X-ray spectrum as the atomic number is decreased with the changes in the structure of the atom as given by Bohr's theory. The paper is divided into three parts. Part I is of a theoretical nature mainly concerned with Bohr's spectrum and atomic theories; Part II is experimental—a very interesting method of measuring intensities of spectrum lines being described; Part III discusses the experimental results in relation to the theory. A concise abstract is not possible. A. B. W.

2207. *Decay and Recovery of Structure of "Gadolinite" in X-Rays.* **H. Küstner.** (Zeits. f. Physik, 10. 1. pp. 41–43, 1922.)—Employing the powder method of Debye and Scherrer for the analysis of crystal structure by means of X-rays, the author has examined the structure of the mineral gadolinite ($(SiO_5)_2Y_2B_2Fe$). Several samples from different sources exhibit marked differences in structure—varying from a well-defined crystalline form to a colloidal or amorphous variety, representing distinct stages of decay and recovery of the crystalline structure. A. B. W.

2208. *Ratio of Mass to Weight for Bismuth and Aluminium.* **H. A. Wilson.** (Phys. Rev. 20. pp. 75–77, July, 1922.)—It was recently concluded by Brush (Phys. Rev. 2. xix. p. 125, 1921), from his experiments on the gravitational attraction of several substances, and on the ratio of mass to weight for some of them, that both these quantities vary for different substances. The greatest difference in the attraction was found in the case of aluminium and bismuth. The present author has tested this pair of substances by the method of Eötvös, a cylinder of each of mass about one gram being attached to the opposite ends of the beam of the torsion balance. The result of the experiments is that the ratio of mass to weight for these two substances is the same to within one in a million. E. H. B.

2209. *Einsteinian Gravitation.* **M. Brillouin.** (Comptes Rendus, 174. pp. 1585–1589, June 19, 1922.)—Schwarzschild's theorem in which the potentials of gravitation are obtained for a liquid sphere of constant density is developed to apply to the case where the density varies in concentric layers and to the general case where the density varies continuously from centre to surface according to a given law of compressibility. The development is mathematical. A. B. C. L.

2210. *Interaction between Radiation and Electrons.* **C. F. Bickerdike.** (Phil. Mag. 43. pp. 1064–1070, June, 1922.)—This paper is offered as a criticism of Jeans' Report on Radiation and the Quantum Theory, [Abs. 1549 (1914)]. The author suggests the possibility of an escape from the conclusion that a "departure from the classical mechanics is to be looked for in the fundamental equations of ether and electricity" by replacing mathematical equations by a direct consideration of the charge as consisting of radiating Faraday lines regarded as states of the ether, and dispensing with mathematical equations. He also suggests the possibility of an escape from the conclusion that energy must, on Newtonian principles, fritter away into the minutest chaotic motions, by supposing the ether replaced by "a medium which would not be quite like ether, a gas, a liquid, or a rigid solid, but having some of the properties of each." G. W. DE T.

2211. *Half-Quanta.* **W. E. Curtis.** (Nature, 109. p. 713, June 3, 1922.)—The Wilson-Sommerfeld principle when applied to the case of a rotating molecule, supposed rigid, leads to the expression $mh/2\pi$ (m integral, h Planck's constant) for the angular momentum of the molecule, and on this basis, with the help of several other assumptions, it has been found possible to account very satisfactorily for the main features of the structure of band series. In the case of the absorption bands in the infra-red due to the halogen acids a discrepancy exists. The observed bands consist of a number of lines distributed, to a first approximation, according to the formula $\nu = \nu_0 \pm m\omega$, where m takes successive positive integral values and ω is a constant. The line corresponding to $m = 0$ is invariably absent. The theoretical expression, on the other hand, is of the form $\nu = \nu_0 \pm (m - 1/2)\omega$. The reality of the discrepancy is therefore dependent on the correct identification of ν_0. Einstein has suggested that theory and observation would agree if, instead of the usual value $mh/2\pi$ for the angular momentum one assumed it to be given by $(m + 1/2)h/2\pi$. In the band spectrum of helium series exist which show the same peculiarity, and in this case the normal (i.e. theoretical) series are also present. Following up Einstein's suggestion the author has found that the abnormal series may in all cases be very simply derived from the normal group by displacing the quantum number by one-half. The six series of the λ5730 band are quoted in illustration. The inference at present seems to be that molecules fall into two classes, according to whether their angular momenta are given by $mh/2\pi$ or by $(m + 1/2)h/2\pi$. Transitions between the two classes do not occur, or, if they do, give rise to no radiation since there are no lines corresponding to changes of one-half in the quantum number. That is to say, whether or no the half-quantum may be involved in the determination of the possible states of a molecule, it does not appear to play any direct part in the radiation process. A. W.

2212. *Quantum Theory of the Secondary Spectrum of Hydrogen.* **J. Marshall.** (Roy. Soc. Edinburgh, Proc. 42. 2. pp. 247–256, 1921–1922.)—A mathematical investigation of the spectral lines emitted by an electron describing quantised orbits about two attracting centres of force at rest. Wave lengths calculated by means of the resulting formula, agree with the wave lengths determined by Watson and by Hasselberg in the secondary spectrum of hydrogen, the agreement being of the same order as that between the observed and calculated values of λ in the primary spectrum of hydrogen, taking Rydberg's constant = 109 675 cm.$^{-1}$ in Balmer's formula. J. S. G. T.

2213. *Another Ether-Drift Experiment.* **R. J. Kennedy.** (Phys. Rev. 20. pp. 26–33, July, 1922.)—The ether-drift experiments heretofore performed seem to have proven the reality of the Lorentz-Fitzgerald contraction, but the explanation of the negative results requires nothing further. The experiment forming the subject of this paper is designed to detect ether drift or to confirm the Lorentz-Einstein time transformation between relatively moving systems, which is an essential part of the theory of relativity. Assuming Huyghen's principle and the Lorentz-Fitzgerald contraction, it can be shown that the paths of light rays relative to a system are unaffected by its motion or orientation in the medium transmitting the light. The relative phases of two homogeneous beams superposed under large retardation are unaffected by the orientation but not by the velocity of the system. The effect sought in this experiment depends on the velocity change due to the alternate adding and subtracting the earth's orbital motion and that of a solar system as a whole. The apparatus and method are fully described. A delicate optical system is used in which a half-shade analyser measures the variation with change of phase of component beams, of the position of the plane of polarisation of a beam resulting from the superposition of two oppositely circularly polarised ones. The change manifests itself as an unbalancing of a uniform photometric field. The smallest effect to be expected according to the classical ether theory is shown to be several times the least detectable with the experimental arrangements, so that conclusive evidence for or against the relativity principle should be obtained. The experiment is being performed by the author at the Palmer Physical Laboratory. H. H. Ho.

2214. *Motion Relativated by Means of an Hypothesis of A. Föppl.* **H. Zanstra.** (K. Akad. Amsterdam, Proc. 24. 9. pp. 1412–1418, 1922.)—Mainly mathematical. The generalised results, amongst which the hypothesis of A. Föppl (by which special inertial systems are fixed) receives particular attention, are discussed in relation to the notions of absolute space and absolute motion according to the various mechanical theories. A. B. C. L.

2215. *On the Curvature of Space.* **A. Friedman.** (Zeits. f. Physik, 10. 6. pp. 377–386, 1922.)—Einstein and de Sitter have arrived at two possible types of universe; the former obtaining the cylinder world, in which space possesses a curvative independent of the time and whose radius of curvature is connected with the total mass present as matter in the space; the latter deducing a spherical world in which not only space but also the universe can be claimed as of constant curvature. Certain assumptions are made corresponding to the incoherence of matter and relative rest, *e.g.*, the velocity of matter is assumed as sufficiently small compared with the fundamental light velocity. The object of the present paper is to derive the cylinder and spherical worlds from certain general assumptions, and to prove the possibility of a world whose space curvature is constant with respect to 3 coordinates which are valid space coordinates and depend on the time, i.e. on the 4th—the time coordinate. This new type is analogous to the Einstein cylinder world. The assumptions fall into two classes, viz. (1) Those which refer to equations that satisfy the gravitational potential, the state, and the motion of matter. (2) Geometrical characteristics of the world. The result is obtained that a stationary world is either the Einstein cylinder world or the de Sitter spherical world, while an actual periodicity of space curvature is found for the periodic world. Present knowledge is insufficient for adequate numerical calculation and decision as to which of these worlds our universe must be assigned, and it is possible that the causality and centrifugal force problems will throw light on the above difficulty.

H. H. Ho.

2216. *The Homogeneous Gravitation Field and the Lorentz Transformations.* **K. Bollert.** (Zeits. f. Physik, 10. 4. pp. 256–266, 1922.)—The connection between the special and the general theory of relativity lies in that in any given gravitational field, local rigid systems of reference exist for every point at which the special theory of relativity is valid. For all freely moving bodies, whose masses are so small that their effect on the field can be neglected, the gravitational acceleration is nil at a point with reference to an infinitesimal system of reference which is freely moving and therefore participates in the gravitational motion. In such a local inertial system a gravitational field is no longer present. Freely moving bodies move according to the inertia law, clocks and measuring rods behave according to the laws of the special theory of relativity. The local inertial systems have a relative acceleration with respect to each other, and it is in general not possible for a finite region to make a transformation of the gravitational field. The author now deals with a homogeneous gravitational field which he regards as one whose field effect disappears throughout its whole extent when considered from a suitable rigid system. According to classical mechanics all things would have independent accelerations, which is impossible in the inertial system where the special theory of relativity holds good. The first part of the present paper discusses this homogeneous gravitation field but restricted to processes in a plane. The second problem dealt with is the determination of the time surface for an observer in the gravitational field, for which the special theory of relativity supplies the necessary basis. The last section of the paper makes a comparison with the general theory. The paper is mathematical throughout.

H. H. Ho.

2217. *Formation and Movement of West Indian Hurricanes.* **E. H. Bowie.** (Monthly Weather Rev. 50. pp. 173–179, April, 1922.)—There are two hypotheses which attempt to explain hurricanes. Counter currents, having their origin in differences in temperature over large areas, may initiate the conditions that give rise to the system of gyrating winds; and the condensation of water vapour may supply the energy necessary to maintain them through considerable periods. The movement of the hurricane is usually attributed to the general drift of the air in the region of the hurricane. Observations appear to indicate that hurricanes are carried forward on the border of the major wind system (the north-east trade) of the tropics, and that as this wind system changes its direction the course followed by the hurricane is changed to correspond thereto.

W. R. C.

2218. *Variation of Pressure and Density with Height in the Normal Atmosphere.* **A. Rateau.** (Comptes Rendus, 174. pp. 1598–1604, June 19, 1922.)—The author compares the results obtained by Soreau for the variation of pressure and density with height with the Lindenberg observations by Lapresle, showing that the agreement between these results is much closer than at first appears. Taking the equations $Z = -A . \log p/p_0$ and $Z = -B . \log \rho/\rho_0$ values of A and B are obtained for both series of observations, and curves plotted between the values of these coefficients and the altitude. Up to about 11 km. A falls off according to a linear law, but beyond that height the relation between A and Z is hyperbolic. The pressure results differ by 1·3 %, which may be explained by temperature variations. The relation between B and Z cannot be expressed in a convenient equation, hence values should be taken from the curve for calculations.

It is pointed out that although a formula of the type $p/p_0 = (1 - aZ)^m$ agrees with the observed values up to 11 km. within 0·14 %, the corresponding density formula $\rho/\rho_0 = (1 - aZ)^{m-1}$ differs from the observations by 3 %. A. W. L.

2219. *Resultants of Winds.* **T. Terada.** (Phys. Math. Soc. Japan, Proc. 4. pp. 125–133, June, 1922.)—Resultant wind (R) is usually obtained by taking the mean wind velocity for each of the 16 directions and adding them vectorially. The "frequency resultant" (F) is obtained by taking the resultant of the frequencies of wind regardless of velocity. It is shown that to a first approximation F is proportional to R, hence the resultant wind of different cloud layers may be obtained by observations of direction of cloud motion alone. The frequency surface is obtained by taking the plane of the vectors as the x,y, plane and taking z as proportional to the wind represented by x,y. Instead of this surface sloping down in all directions from the origin as might be expected, there is a minimum at the origin which points to some cause preventing the occurrence of weak winds. It is suggested that a weak wind would make convection operative and so increase the ground wind. In observations of wind the mean direction is usually recorded, while the velocity is taken as the algebraic mean and not the vectorial. The difference between these means is shown to be considerable if the gustiness is large.

A. W. L.

2220. *On the Arrival of Earthquake Waves at the Antipodes, and on the Measurement of the Focal Depth of an Earthquake.* **H. H. Turner.** (Roy. Astron. Soc., M.N. Geophysical Supplement, 1. [13 pp.] March, 1922.)—A formula is given for the reception of primary waves at stations near the hypocentre. The mean error of the formula for a single earthquake system shows a systematic error for each particular earthquake which is ascribed to a particular depth of focus. W. R. C.

2221. *The Structure of the Universe and General Relativity.* **E. M. Lémeray.** (Comptes Rendus, 175. pp. 261–263, July 31, 1922.)—In a spherical universe of average constant density there is an apparent stellar concentration in the neighbourhood of the plane perpendicular to the straight line joining the observer to the centre of the sphere. The visible universe may not, however, be so constituted owing to insufficient accord between the expression for the theoretical distribution and that deduced from stellar measurements. If the observer of parameter ρ measures the speed of the light either in the radial direction or normal to it, two different values will be found whose ratio is $\sqrt{1 - \rho^2/a^2}$. Now aberration observations and direct measurements at the earth's surface have never exhibited this difference, and the author has investigated the modification of the hypothesis of average constant density while retaining that of a spherical universe. As a result he suggests the speed of light being measured under certain conditions, which he describes, for testing the validity of his new hypothesis. H. H. Ho.

2222. *Einstein Displacement at Solar Eclipse.* **C. Davidson.** (Observatory, 45. pp. 224–225, July, 1922.)—The star field of the 1919 eclipse was unusually favourable in the number of bright stars available. That of 1922 is much less favourable, and if exposure is increased to give fainter stars, they will probably be drowned in the corona. If the scale of the photograph is determined independently, two stars each 1° away on opposite sides of the sun, should show an increase in distance of 0″·88, easily measurable on good photographs. If the telescope is turned through a suitable distance in R.A. or Decl. between successive exposures on the eclipsed sun, comparison fields can be photographed on the eclipse plates, and two suitable fields are suggested. This will, of course, halve the number of eclipse plates taken, but their value would be much increased. This method can be employed at the 1923 eclipse which is still less favourable, and in fact it will give results at almost any eclipse. W. W. B.

2223. *Calculation of Heliographic Coordinates.* **E. Merlin.** (Comptes Rendus, 174. pp. 1536–1539, June 12, 1922.)—The author deduces formulæ suitable for tabulation, using data given in the *Connaissance des Temps,* from which coordinates can be found with accuracy only restricted by that of the data. He considers the parallax to be known within a few thousandths of a second of arc, the Right Ascension of the sun to 0″·01, and the Declination to 0″·1. The feature of the formulæ is the choice of subsidiary quantities which can readily be determined within this order of accuracy demanded. W. W. B.

2224. *Interpretation of Apparent Changes in Mean Latitude.* **W. D. Lambert.** (Astron. J. 34. pp. 103–110, July 3, 1922.)—This paper gives in greater detail the data from International Latitude stations, on which was based the author's paper [see Abs. 1253 (1922)], dealing with a possible movement of the earth's pole towards the American continent. The stations employed were Mizusawa, Tschardjui, Carloforte, Gaithersburg, Cincinnati, and Ukiah, but only the first, third, and last of these give data for the full period 1900 to 1917, Cincinnati stopping at 1915 and the other two at 1914. It is established that a revision of the proper motions in declination of the stars used by the latitude stations will not account for the whole of the reported motion, which is of the order of 20 cm. annually, so the question arises as to whether a motion of the pole itself, or a local creep of the surface at a station is more likely. Reasons are given for rejecting the data from Tschardjui, a station known to be considerably affected by the change of position of the bed of a neighbouring river. The figures from Mizusawa, and to a less extent from Carloforte, stand out from the rest, after the declinations are adjusted. The American stations show a progressive approach of the pole in 1900 to 1914, but the probable error is increased by an apparent discordance due to Cincinnati, which in the years 1900 to 1911 disagreed more. The inclusion of 1912–

1914 reduced this, and the tendency shown in 1915 at Cincinnati would seem to reduce it still further. More recent data for Ukiah show that in 1918, 1919, and 1920 the pole appears to be swinging away from the American continent, so that the motion up to 1917 may only be part of a cyclic change; or the sum of many contributing factors which at that time had an effect mainly in the same direction, the factors being probably connected with meteorological or climatic cycles. The elastic-rebound theory of earthquakes is considered in relation to these crust movements, but none of those hitherto investigated point to a motion of more than 4 or 5 cm. per annum, so that 20 cm. per annum would seem to require a far more powerful earthquake than any of these. The conclusion arrived at is that the movements discussed are not due to earthquakes, but that there is some motion of the pole, and that a more detailed discussion of the proper motions of the stars used is necessary to reduce them all to a consistent system. Meanwhile it is important to bring the latitude observations up to date. W. W. B.

2225. *Low Sun Phenomena.* **W. J. Fisher.** (Astron. Obs. Harvard Coll. Ann. 86. pp. 38–45, 1922. Reprint.)—In continuation of previous work [see Abs. 748 (1922)], the author gives details of 83 observations, extending from 1918 December 22 to 1921 August 21, mostly taken at sunset, but including some at sunrise, at varying heights. Generally the results confirm those of previous work. Type B sunrise and sunset lasting distinctly longer than the theoretical calculated duration, care was taken to minimise the possible effect of irradiation. Some of the differences amount to one or two minutes, but it is considered quite impossible that these are due to error of observation of the time. W. W. B.

2226. *Small Haloes of Ytterby.* **J. Joly.** (Nature, 109. p. 711, June 3, 1922.)—The author publishes a letter from Svein Rosseland in which interesting theoretical speculations are given as to the origin of the specks in the ytterby mica which give rise to the very small haloes observed by the author. He deduces that the radio-active substance at the centre of the halo must have an atomic weight about 40 and is most probably yttrium. Reference is given to a paper by L. Nordenskjöld in which yttrium is shown to be present in ytterby mica. This supports Rosseland's theory. A. B. W.

2227. *Spectrum of o Ceti in 1919.* **C. D. Shane.** (Lick Observat., Bull. 10. No. 335. pp. 131–134, 1922.)—The spectrum was photographed in the visual and ultra-violet regions during the 1919 maximum and part of the decline towards minimum. More than sixty absorption bands were measured in the visual region, mostly belonging to the band spectrum of TiO_2, but some possibly due to Y. The red end of the visual spectrum became relatively stronger as the star faded and the absorption bands much more prominent. The first seventeen lines of the Balmer H series were observed as bright lines. Some of the H emission lines are abnormally faint; but as they coincide with strong lines of Fe and V it is supposed that overlying metallic vapours are responsible for the faintness. H_α was displaced 1 Å. towards the violet with reference to the other H lines. H_κ was displaced through the same amount towards the red at maximum, but returned to its normal position on the decline two months later. Details are given of the five different spectrographs used in the investigation, four of them in conjunction with the 36-inch refractor and the other with the Crossley reflector. W. W. B.

2228. *Roche's Limit for Satellites.* (Nature, 110. p. 89, July 15, 1922.)—Roche's limit for the minimum distance of a satellite from its primary (varying with the latter's density, but of the order of 2½ times its radius), takes no account of cohesion. The disruptive force for bodies of the size of the moon would be so large that cohesion could be neglected, but for small bodies like Phobos the case is different. J. Darwin suggested that Phobos is so near Roche's limit that future astronomers might see it break up. Fountain, in the British Astronomical Journal for May, on the hypothesis of a tenacity equal to that of brick or cement (300 lbs. per square inch) computes that Phobos could reach the surface of Mars without breaking up, and that in its present position a satellite even of 200 miles in diameter need not break up. Bodies of this size could also exist at the inner edge of Saturn's ring, so that in that case also Roche's limit cannot be invoked as an explanation of the small size of the ring particles. W. W. B.

2229. *Plaskett's Massive Star.* (Nature, 110. p. 53, July 8, 1922.)—The star is in Monoceros, in the middle of the galaxy, R. A. 6h. 32m. N. Decl. 6° 13′ (1900), 6·06 visual mag. Draper Catalogue gives Bop, Plaskett Oe5, orbital velocities of components 206·38 and 246·7 km./sec. period 14·416 days, eccentricity 0·0349, minimum masses 75·6 and 63·3 times that of sun. There are no eclipses, so orbit is at least 17° from edgewise position, and masses should be increased at least 14 per cent. The centre of gravity recedes at 23·94 km./sec., H and K show no orbital motion, but recession 15·9 km./sec., which is the resolved solar motion, so that the Ca, as in several other spectroscopic binaries, is at rest in stellar system. Estimated density $\frac{1}{100}$ that of sun; surface brightness 4 magnitudes greater than sun; diameters 20 and 18 times that of sun; distance between centres 65 solar diameters; distance from earth 10,000 light years; absolute magnitude of brighter component—5·65. Recession of centre of gravity corrected for solar motion is 8 km./sec., of which, assuming the dimensions and masses above, the Einstein spectral shift would account for 2·8 km./sec. The star is so near the mean galactic circle that it is suitable for the zero of galactic longitude. W. W. B.

2230. *Temperature of o Ceti.* **E. A. Milne.** (Observatory, 45. pp. 223–224, July, 1922.)—The author draws attention to a note on this subject by Nicholson and Pettit in the April number of the Publ. of Astron. Soc. of the Pacific. The ratio of total radiation to visual brightness is much larger than for a typical Ma star. Moreover, a water cell of 1 cm. thickness transmitted only 31 per cent. of the radiation from o Ceti, instead of 38 or 39 per cent. for a typical Ma star. Three months later the star was about 1 magnitude brighter, but the increase in total radiation was only 0·3 of a magnitude. From these two types of observation a low effective temperature for the star is inferred, showing a large proportion of the energy to lie in the infra-red, and most of it outside the visible spectrum. A rough estimate of the temperature is 1700° C. The star, however, has a range of about 7½ magnitudes and it appears that an increase of this amount would correspond to a temperature of 3000° C., so that at maximum the star would conform to the normal temperature for a M star. The reason why a drop of several magnitudes from 3000° is equivalent to a drop of only ½ magnitude from 8000° is clearly shown from the energy-curve of black-body radiation. What is required now is the radiation curve at all stages of the star's light change. W. W. B.

2231. *General Relativity and the Milky Way.* **E. M. Lémeray.** (Comptes Rendus, 175. pp. 91–94, July 10, 1922.)—According to recent opinion the Milky Way is a stellar cluster having a form almost lenticular, the solar system being near the centre. Certain astronomers regard nebulæ as alien to the Milky Way, while others, such as Proctor and Seliger, opine that on the average they are not more remote than the stars, their number increasing towards the poles of the Milky Way. The author now attempts to show that the theory of relativity enables an entirely different structure to be conceived for the whole stellar universe. This he approaches from the nebula standpoint, taking a globular cluster whose star distribution to an observer at the centre will be uniform, but on the classical theory of light should be a maximum in the direction of the centre and a minimum in the contrary direction. On the relativity theory the light rays are curves and the consequences of curvature are examined, this affording an entirely new presentation of the problem. The paper is mathematical throughout. H. H. Ho.

2232. *Dark Structures in the Milky Way.* **T. E. Espin.** (Roy. Astron. Soc. Canada, J. 16. pp. 218–229, July–Aug., 1922.)—Ten years ago the author suggested that the dark structures in the Milky Way might be explained by a vast number of what are most like absorption vortex rings seen at all angles and consequently appearing as ellipses. A study of Milky Way photographs taken by different observers with different instruments, but especially by Barnard, has resulted in the present catalogue and description. The author divides the objects for convenience into six classes: (1) Dark spots catalogued by Barnard, and so omitted now; (2) Stars showing absorption close round them; (3) Oval absorption where background is mostly blotted out; (4) Clusters, nebulæ, and groups of stars, with absorption rings generally seen as ellipses; (5) Stars with absorption connected with them; (6) Stars with rings generally seen as ellipses round them.

The accompanying descriptive catalogue includes 202 objects, and the author draws some tentative general conclusions in addition to notes on special cases. He considers that similar objects may be found elsewhere than in the Milky Way, that the rings are many times greater in diameter than in thickness, so that the absorptive effect on the stellar spectrum might show a slow progressive change as the angle of presentment is altered by proper motion, and that probably all stars, clusters, and nebulæ are surrounded by a ring of absorption; that round the brighter stars being of great extent and very likely involving quite distant stars in a common motion. W. W. B.

2233. *Jupiter Perturbations of* (10) *Hygiea and* (175) *Andromache.* **A. O. Leuschner.** (Nat. Acad. Sci., Proc. 8. pp. 170–173, July, 1922.)—These two planets belong to the Hecuba group, with mean motion approximately twice that of Jupiter. From time to time their orbits have had to be corrected by special perturbations which not only require repetition of the work at intervals but also continuous observation of the planets whenever possible. Recently the perturbations have been developed by Estelle A. Glancy and Sophia H. Levy on the basis of a revision of von Zeipel's formulæ and tables. The results of comparisons of the revised tables with observation are very encouraging and prove that these revised tables provide a satisfactory representation of the motion of the planets of the Hecuba group. The author considers that this will do away with the necessity for frequent observation, and for the computation of special perturbations between each opposition. He gives in each case particulars of the discovery and subsequent theory of the two planets, and suggests that a similar process should be applied to other groups of planets with mean motions approximately commensurable with that of Jupiter. **W. W. B.**

2234. *Right Ascension and Parallax of Nova Aquilæ 3.* **J. Trousset.** (Bull. Astronomique, 2. 5. pp. 361–363, 1922.)—Meridian observations at Bordeaux were taken from 1918 to 1921 of Nova Aquilæ and the neighbouring star B.D. +0°·4023, and seeing the large probable error of the parallaxes determined by different observers [see Abs. 88 (1922)], the author is encouraged to deduce one from his observations of Right Ascension. His result is $+0''{\cdot}16 \pm 0''{\cdot}09$. **W. W. B.**

2235. *On the Behaviour of a Small Body within the Cassini Division of Saturn's Rings.* **W. M. H. Greaves.** (Roy. Astron. Soc., M.N. 82. pp. 360–367, April, 1922.)—A mathematical analysis, with comments on a paper by Goldsbrough. [See Abs. 493 (1922).] **W. W. B.**

2236. *New Interference Method for Measuring Apparent Diameters of Stars.* **A. Danjon.** (Comptes Rendus, 174. pp. 1408–1410, May 29, 1922.)—Michelson's "Fizeau" method requires a large distance between the pencils of rays, 12 metres for a star whose diameter is $\frac{1}{100}$ second of arc. Moreover, the fringes disappear gradually, so that no quantitative measures are possible. The author considers these drawbacks to the method and proposes to avoid them. Laboratory experiments at Strasburg have been successful, but bad weather has prevented actual application to stars. Fringes are produced in this field of view alternately bright and dark, and the star is displaced across them. If its diameter is insensible it will be quite eclipsed by the dark fringes. If it has a sensible diameter it will fade partially and its diameter can be deduced from the amount of the loss of light. The precision of the method the author states to be about one-fiftieth of the width of the interference fringe. He explains his apparatus and hopes to measure Betelgeuse when it returns this year. He thinks it will be possible to measure diameters of $\frac{1}{20}$ second of arc with certainty. **W. W. B.**

2237. *Temperature of Outer Atmosphere of a Star.* **E. A. Milne.** (Roy. Astron. Soc., M.N. 82. pp. 368–371, April, 1922.)—The purpose of the author is to generalise results obtained for grey material by Schwarzschild and Humphreys. Using the word *stratosphere* to denote the outer quiescent forms of a star's atmosphere, the result is that "If the stratosphere of a star is in radiative equilibrium, its temperature will fall off as the inverse square root of the distance, provided it is composed of gray material. In any case, its temperature cannot fall off more rapidly than the inverse square of the distance, but the temperature distribution may be nearly isothermal, the exact law depending on the part of the spectrum which it absorbs. The inverse square distribution corresponds to absorption in the far infra-red, the isothermal distribution to absorption in the far ultra-violet. "Grey" means that the absorption coefficient is the same for all wave-lengths. W. W. B.

2238. *Systematic Distribution of Ca Flocculi.* **C. P. Butler.** (Roy. Astron. Soc., M.N. 82. pp. 334–356, April, 1922.)—During the period 1915–1920, spectroheliograms taken in monochromatic light (K_{232}) show that a considerable proportion of the masses of flocculi tend to become elongated in a westerly direction towards the equator in both hemispheres. The proportion of these elongated groups seems to increase gradually before maximum, but irregular groups predominate after maximum. The inclinations to the parallels of latitude range generally from 0° to 40°, with few even as great as 90°, a greater range than that shown by the axes of spot-groups. Moreover, the high angles do not increase with latitude as in the case of spots, but are widely distributed in latitude. There are signs of maximum frequency of inclinations about 15°, 21°, and 28° to 32°. There appears to be a periodicity in time in the alternation of high and low inclinations, but the phase does not quite agree in the two hemispheres. The only points of difference in the six years, which included the maximum of 1917, were the variation in the total numbers and in the proportion of elongated to irregular groups. W. W. B.

2239. *Observations of Nova Persei* (1901), 1921–1922. **W. H. Steavenson.** (Roy. Astron. Soc., M.N. 82. pp. 403–404, May, 1922.)—Continuation of previous paper [see Abs. 803 (1922)], contains the author's observations, with several different instruments, of Nova Persei from 1921 August 6 to 1922 March 25. The star is now an irregular variable, and its light curve seems to include many periodicities, long and short. Turner's note suggests a period of at least six years, and his analysis of Barnard's observations one of 396 days. In these the minor oscillations have been ignored, and the author thinks them real, repeating at a 114-day interval. He wants nightly observations for a long period to settle this point, and thinks much is lost by combining observations by different observers, because of their very different sensitiveness to the faint nebulosity, only visible as a rule to averted vision, and consequently exaggerating the brightness of the nova. W. W. B.

2240. *On Colour Indices and the Spectra of the Double Stars.* **G. Abetti.** (Accad. Lincei, Atti, 31, i. pp. 359–363, May 7, 1922.)—The bulk of the paper is devoted to discussing and tabulating the results arrived at by other investigators, principally Struve and Dembowski. The author says in conclusion that in order to arrive at a more complete knowledge of the colour indices of the double stars, extending it to those with components of very different luminosity, the method which at once suggests itself is that of determining the photographic and photovisual dimensions with instruments of focal distance sufficiently large to admit of separating the components. He has himself initiated a research on these lines with the Amici equatorial, which gives good photographic and photovisual images. E. F.

2241. *On the Retrograde Satellites.* **P. Burgatti.** (Accad. Lincei, Atti, 31. i. pp. 239–242, April 2, 1922.)—The existence of satellites with a retrograde motion is a phenomenon which causes very serious difficulties in the cosmogonic theories. Especially striking is the fact that they are the most distant from the respective planets. It would therefore appear that direction of motion and distance are two closely allied factors and such as almost to justify the assumption that the retrograde satellites have a different origin from those whose motion is direct, which latter, from Kant and Laplace onwards, have been considered as more or less closely related to the planets. But is this opinion, even expressed by astronomers of authority, in accordance with truth? The author thinks that the present stage of our knowledge does not admit of a definite reply, and that the problem cannot be solved by pure mechanics. Nevertheless, mechanics can assist by elucidating certain essential differences between the two classes of satellites. The problem has here been reduced to its maximum simplicity by eliminating all but the essential factors. Let us consider the restricted problem of the three bodies. The orbit of the satellite is in the plane of the planetary orbit, and the mass of the satellite T is sufficiently small not to affect appreciably the motion of the planet P, which revolves around the baricentre O sun-planet uniformly and in a circle. The motion of T is connected with the rotating axes $OP \equiv Ox$ and Oy perpendicular to Ox. But the axes may be considered fixed, provided that to the attractive forces acting on T be added the centrifugal force and the Coriolis force with its direction reversed. It is evident that this latter force is the only one which varies in direction in passing from a direct to a retrograde satellite. The others would allow the satellite to describe an orbit in either direction. It is directed towards the centre of curvature in the retrograde motions and in the opposite direction in the direct motions and is therefore the reason of the different behaviour of the two classes of satellites. This being established, we are naturally led to consider whether it be permissible to disregard two of the other forces: the attractive force of the sun and the centrifugal force. Then follows a mathematical exposition leading to the conclusion that the problem may be reduced to that of the motion in a plane of a solid point acted upon by the Newtonian force emanating from a fixed centre and by the Coriolis force, a comparatively simple problem analogous to that of the motion of an electron round an atomic centre in a constant magnetic field. It is sufficient to take the integrals of energy and of the areas with respect to certain axes, from which, passing to polar coordinates, we may derive a relation of the type $d\rho/dt = \sqrt{f(\rho)}$, where the equation $f(\rho) = 0$, of the fourth degree, has always two real roots. This shows that each trajectory is developed within a circular corona. If the roots be very close together, the orbit will be in almost circular spirals. The differential characters of the direct and of the retrograde orbits will coincide almost exactly with those of the absolutely circular orbit. E. F.

2242. *Spectra of Physically Connected Pairs and the Giant and Dwarf Theory.* **P. Doig.** (Roy. Astron. Soc., M.N. 82. pp. 372–381, April, 1922.)—Examining the data available for 111 pairs of stars, with the expectation that in general the fainter one is the less massive and so probably further advanced in evolution, on the hypothesis of origin by fissure, it becomes necessary to discriminate between giants and dwarfs.

Conclusions are that in connected pairs, in which the primary at least is a giant, the fainter star is generally of a so-called "earlier" type, and progressively so with increase in differences of brightness of components. If, however, both are dwarfs, the fainter is usually of a so-called "later" type and progressively so with increase in difference of brightness. This gives a criterion of giant and dwarf classification which may perhaps be extended to clusters or groups of connected stars. In connected systems the fainter stars seem generally further advanced in development, perhaps on account of smaller mass.

It appears thus that there is very little chance of the "capture" theory being true. Also approximate parallax may be obtained, when difference of brightness or spectrum is large, by classifying into giants and dwarfs, and using the probable absolute magnitudes corresponding to the several types. Such parallaxes will be more accurate in the case of dwarfs. Examples of this are given, including the Præsepe.

W. W. B.

2243. *Widened Lines in Sirius Spectrum.* **J. Evershed.** (Roy. Astron. Soc., M.N. 82. pp. 392–396, May, 1922.)—Using a dispersion five times greater than Lockyer's, ranging from 1·3 Å. to 2 Å. per mm. and including the region between λλ4220 and 4700 the author finds, in the Sirius spectrum, Hγ with a definite nucleus and a broad shading about 10 Å. on either side. The metallic lines are wide and have well-defined edges. Comparing with the Venus spectrum the lines in Sirius are much wider and fainter than solar lines, and are grey instead of black, with the exception of enhanced Mg line 4481·3 and the line 4549·8, which are nearly black. The author tests various explanations and rejects pressure, since the widths do not increase much towards the violet. Similarly he rejects the magnetic Zeeman effect. He thinks the widening most probably a Doppler effect, but evidence is against the star being a spectroscopic binary. The high temperature of Sirius will not account for the widening. If it is due to rapid rotation it appears to indicate a rotation of Sirius in about 8 days or less, which is very improbable, as Sirius is in an earlier stage and less condensed than the sun. A further suggestion of radial convection currents cannot well be tested, though there is some analogy in the sun. The author suggests wide dispersion spectra of other Sirian stars to test whether the effect is peculiar to Sirius or common to A stars.

W. W. B.

2244. *Motion of a Planet in a Resisting Medium.* **P. Fatou.** (Bull. Astronomique, 1. 6. pp. 293–301, 1922. Comptes Rendus, 174. pp. 1162–1165, May 1, 1922.)—Tisserand's "Mécanique Céleste" appears to be practically the only original authority on the theory of motion in a resisting medium, Poincaré merely repeating it with very slight modification. It seems to the author, however, that in respect of the effect on the longitude of perihelion, Tisserand's work is incomplete and even inaccurate. He shows that the longitude of perihelion has a positive secular variation of the order of the square of the disturbing force, and in the special case of Mercury he finds that to displace the perihelion 40″ per century, the disturbing force will have to bear to that of gravitation a ratio of three to ten thousand. For a circular orbit this argument will not hold, but Mercury's great eccentricity makes it important. He finds that the radius vector can only become zero after an infinite time. A further modification of his results will be necessary for the cases of rectilinear and hyperbolic motion, and these he postpones to a future article. W. W. B.

2245. *Motion of a Planet in a Resisting Medium.* **P. Fatou.** (Comptes Rendus, 174. pp. 1330–1332, May 22, 1922.)—Previously [see preceding Abstract] the author has studied the motion of a point under a central force acting according to the Newtonian law, but in a medium whose resistance is proportional to the velocity. He now extends the study to more general laws of resistance. He assumes that the orbital velocity cannot become zero in a finite time, or else the moving body (or point) would fall suddenly to the centre, causing a discontinuity in the motion. He states also that "If $f(x)$, continuous as regards its first n derivatives, admits at least one finite limit of indetermination when x becomes infinite then the derivatives must admit a zero limit of indetermination. Hence in an infinite time it is impossible that r should tend to a finite limit greater than zero, while θ also tends towards a finite limiting value." There are then two possibilities: (1) r tends to become zero while θ has a finite limit, in which case the path is always concave to the origin and is of finite length, or (2) when r tends to become zero, θ becomes infinite, indicating spiral movement. This second case holds when the resistance is proportional to the velocity or the square of the velocity. W. W. B.

2246. *Differential Refraction in Positional Astronomy.* **W. B. Varnum.** (Astron. J. 34. pp. 61–82, June 5, 1922.)—An exhaustive discussion of a large quantity of data, some of which was specially obtained, in order to find an explanation of the difference between night and day observations, has resulted as follows. There is a varying prismatic effect due to the changes in the strata of the atmosphere, the total effect being essentially a shift of the meteorological zenith. This shift is controlled by the temperature, not the barometer. Expressions have been derived for the effect on observations, and when these are applied the "night-day" difference is substantially reduced. The diurnal term would have vanished if humidity and *sun* temperature had been used in the original solution. This term is due to the atmosphere and its law is $a \sin (\alpha - \odot) + b \cos (\alpha - \odot) + c \sin 2(\alpha - \odot) + d \cos 2 (\alpha - \odot)$. The systematic corrections depending on the Right Ascension have been practically eliminated, and the observations north and south of the zenith brought into better agreement without introducing a constant. Tests of published results of other observatories show that the phenomenon is not local. W. W. B.

2247. *Distribution of Velocities of Late-type Stars.* **G. Strömberg.** (Nat. Acad. Sci., Proc. 8. pp. 141–146, June, 1922.)—Recent work has made it possible to compute the absolute motions in space of about 1300 stars of types A7 to M, from their proper motions and radial velocities. The deduced solar motion is tabulated from groups of types A6 to F9, G0 to G9, K0 to K9, and M, the giants and dwarfs in the first three groups being separated. It appears that the declination of the sun's apex shows a steady increase from 27° to 44° with advancing type of giant stars. The dwarfs indicate a much larger velocity for the sun than that given by stars in general. The sun's velocity is greater the greater the velocity of the stars used for reference.

The giant stars of all types form a single "stream" with an ellipsoidal distribution, the shortest axis being perpendicular to the galaxy and the other axes approximately agreeing with those of the galaxy. The elongation of the ellipsoids is largest for bright F stars and decreases with later types, being almost spherical for M stars. The most frequent velocity lies not at the origin but in the first quadrant ($x = +5{\cdot}6$, $y = 2{\cdot}3$, $z = +1{\cdot}6$ km./sec). Excluding the very brightest F stars (many of them Cepheids), the stars of types A7 to F9 of absolute magnitudes 0 to 6, divide themselves into two streams, one coinciding with the general group of giants, and the other, moving nearly parallel to the Taurus cluster, may be identified with Kapteyn's First Drift. The dwarfs (magnitude 3 and fainter) seem to form a group of their own, nearly coinciding with Kapteyn's First Drift.

Stars of high velocity show a tendency to avoid the first quadrant. Omitting them, the mean of the velocity components falls near the origin. In fact, a large proportion of the stars with velocities > 100 km./sec. are moving towards the third quadrant and none towards the first. This result agrees with Adams and Joy's results at Mt. Wilson. [See Abs. 1029 (1921).] W. W. B.

2248. *Determination of Sun's External Magnetic Field from the Coronal Structure and the Constants of Aurora Borealis.* **C. Störmer.** (Comptes Rendus, 174. pp. 1447–1448, June 6, 1922.)—In a previous paper [see Abs. 733 (1911)] a relation was found between the moment M of the sun's external magnetic field and the characteristic product H_ρ of the electric corpuscles causing aurora. $H_\rho = (m/e)v$ when m is the mass, e the charge in electromagnetic units and v the velocity of the corpuscle. Since that approximate result was given, observations of aurora at Bossekop in 1913 have given a value of $H_\rho = 700$, or a velocity of the order of 120,000 km./sec. The resulting values for the force along the axis and in the equatorial plane are $1{\cdot}2 \times 10^{-7}$ and $0{\cdot}6 \times 10^{-7}$ of the same order as those found by radial velocity methods in 1911 by Deslandres. The stronger field found by Hale from the Zeeman effect is different and comes from a deeper layer of the sun. W. W. B.

2249. *Cause of Encke's Division in Saturn's Ring.* **G. R. Goldsbrough.** (Roy. Soc., Proc. 101. pp. 280–289, June 1, 1922.)—The effect of a satellite moving in an orbit inclined to the plane of the Rings is to produce one new division. Mimas should produce one at a distance of 19″·05 from Saturn, which closely corresponds with Encke's division. Enceladus should produce a division at 16″·5, but Enceladus is distant and its orbital inclination small, so this division would be very feeble, and none has yet been observed in this place. W. W. B.

2250. *Radial Motion of Spirals and Clusters.* **C. Wirtz.** (Astron. Nachr. No. 5153. Nature, 109. p. 791, June 17, 1922.—Abstract.)—Out of 29 spirals only four show approach. A systematic recession of 840 km./sec. is deduced. Nebulæ in lower galactic latitudes tend to approach, and those in higher latitudes to recede. Brighter ones (nearer or more massive) tend to approach and fainter ones to recede. Ten globular clusters indicate a systematic approach of 55 km./sec. The number is too small for analysis, but there is some evidence of greater velocity in low galactic latitudes and of increasing velocity with increasing distance. The deduced solar apices from these two classes are quite near together, but the spirals are so much swifter than the clusters that this may be fortuitous and no indication of a connection. Trustworthy proper motions of the spirals used would enable a good estimate of their distances to be derived. The few proper motions available point to a solar apex 52° away from one formed from radial motions, but as the material is so meagre this is not perhaps altogether discouraging.

W. W. B.

2251. *Origin of Asteroids.* **K. Hirayama.** (Scientia, June, 1922. Nature, 110. p. 53, July 8, 1922.)—In continuation of his work on families of comets [see Abs. 390 (1921)], the author considers the various theories of origin that have been put forward since the old idea of an exploded planet was discounted by the wide range of orbits. The notion that Jupiter's disturbing action prevented the nebulous ring in the asteroid region from condensing in a single planet is met by the argument that Jupiter's four great satellites are quite near it and much bigger than any asteroid. The theory of Jupiter's capture of fragments from a distance is negatived on the ground that many of the orbits do not approach near enough to Jupiter, and that the major axes show very little perturbation. The author favours Young's suggestion that each family of comets represents a separate explosion. He thinks the rapid and irregular light variation of many asteroids, notably Eros, shows them to be irregular fragments, too small to be made spherical by their own gravitation. Possibly all the exploding bodies formed at one time a single planet.

The total mass of the known asteroids is only $\frac{1}{3000}$ that of the earth, so he thinks many fragments must have been absorbed by the sun and Jupiter. He also suggests a similar origin for Saturn's ring, which resembles the asteroid system in many points. W. W. B.

2252. *Radiative and Convective Temperature Gradients.* **R. d'E. Atkinson.** (Observatory, 45. pp. 190-191, June, 1922.)—In a previous paper [see Abstract No. 2254 (1922)] it was assumed that the temperature gradient in the reversing layer of stars is determined by convection rather than by radiation, and the present note is intended to justify this in reply to a question. Making various assumptions in order to reduce to a probable numerical expression, the author shows that unless the spectrum had very many lines, the radiation energy which the gas can absorb is inadequate to prevent considerable adiabatic cooling. If many absorbing lines are present the temperature gradient might approach the radiative value. W. W. B.

2253. *Observations of Type N Stars, Especially One with a Very Low Effective Temperature with the Heterochrome Photometer.* **C. Nordmann** and **Le Morvan.** (Comptes Rendus, 174. pp. 1690-1692, June 26, 1922.)—Continuing work with the heterochrome photometer [see Abs. 515 (1922)] three carbon stars have been examined: Harvard Revised Photometry No. 4195, magnitude 6·32; Y Canum Venaticum var. 4·8 to 6·0, and RY Draconis var. 6·1 to 7·1.

The method has been previously described. The resulting effective temperatures of the three stars are respectively in absolute scale, 3440°, 3010°, and 2164°. The first of these is practically equal to that found for Aldebaran, and the first two furnish evidence that carbon stars are not necessarily cooler than M stars such as Betelgeuse, contrary to common assumption. The third star, with a temperature of 1877° C., is the coolest yet encountered, scarcely warmer than the bright part of a petrol flame. There is thus considerable range of temperature in carbon stars.

Comparison with Coblentz [see Abs. 1546 (1922)].—In the course of the work by the heterochrome method, eight stars occur of the sixteen recently measured by Coblentz with very sensitive thermopiles. A comparison of the results is given [see Abs. 515 (1922)] elsewhere.

	Type.	Coblentz.	Authors.
Vega	Ao	8000°	12,200°
Sirius	Ao	8000	12,200
Procyon	F5	6000	6800
Capella	Go	6000	4700
Aldebaran	K5	3500	3500
Betelgeuse	Ma	3000	2750
β Andromedæ	Ma	4000	3700
μ Geminorum	Ma	3500	3200

The accordance is good except for the two A stars, for which Rosenberg by photographic methods has obtained even higher values (22,000° for Vega), so that the value of the author's method is confirmed.

W. W. B.

2254. *Pressure in Reversing Layer in Stars.* **R. d'E. Atkinson.** (Roy. Astron. Soc., M.N. 82. pp. 396–402, May, 1922.)—Stars of classes K5 to M show signs of TiO_2 absorption. If the temperature of one of these stars is known, the pressure in its reversing layer can be deduced from the behaviour of these absorption lines, provided that the effect of temperature and pressure on the equilibrium of TiO_2 is known. Fabry and Buisson [see Abs. 786 (1909)] deduced from the pressure shift a pressure of between 1 and 10 atmospheres for the sun's reversing layer. The present paper points to a pressure one-millionth of this. TiO_2 is only observed in stars so cool that the pressure in the reversing layer is high enough to prevent dissociation at that temperature. No other compounds appear until much lower temperatures, since few other oxides are formed with so high a heat of reaction, except such as have many more atoms per molecule (*e.g.*, Al_2O_3). The oxides of Ce and Th, especially the latter, have higher heats of formation, but have not yet been found to give an absorption spectrum in any star, perhaps on account of high molecular weight or possibly rarity of these elements. Titanium is the tenth commonest element. Several halides give high heats of reaction and are being investigated. The high relative strength of the TiO_2 spectrum in some cases is another problem, and may be connected with the tendency to variability in such stars as have compounds present in their atmospheres. **Erratum** (*ibid.* p. 494, June, 1922.) W. W. B.

LIGHT.

2255. *Method of Determination of the Velocity of Light by Means of Ionisation Measurement.* **H. Greinacher.** (Zeits. f. Physik, 10. 1. pp. 63–68, 1922.)—The author proposes to measure c indirectly by measuring the same electrical quantity in electrostatic and electromagnetic units. The method proposed involves the measurement of the thermionic current from a hot filament in a vacuum tube. A. B. W.

2256. *The Spectral Distribution of Energy Required to Evoke the Grey Sensation.* **I. G. Priest.** (Bureau of Standards, Bull. 17. pp. 231–265, [Sci. Papers No. 417] 1921.)—The chief significance of this paper lies in the development and testing of an experimental method for determining an objective physical standard of "white light." The standard to be determined is the Planckian ("black-body") distribution of energy required to evoke the hueless sensation of brilliance, commonly called "white" or "grey," under certain standard conditions stated in detail in the paper. Light from a lamp of known spectral distribution is modified by rotatory dispersion in a system of quartz plates and Nicol prisms in such a way that by rotating one of the nicols the light emerging from it can be made to assume the spectral distribution of a Planckian radiator at any desired temperature between 4000 and 7000° K. Such a system is, in effect, a selective light filter of adjustable spectral transmission.

Two methods of observation are described: (1) The method of adjustment by trial, in which the observer himself adjusts the stimulus until he calls the sensation "white." (2) The method of answers, in which the operator conducting the experiment adjusts the stimulus to correspond to certain fixed temperatures of the hypothetical Planckian radiator and records the observer's reactions as "blue," "white," or "yellow," as the case may be. The latter method proved to be the more satisfactory. Experimental results are given from four observers. The average results of these observers indicate that "white light" may be represented: (1) Theoretically, by the light from a Planckian radiator at a temperature of about 5200° absolute; (2) practically, to a fair approximation, by average noon sunlight at Washington. It is, however, emphasised that the final establishment of such a standard should be based on a more extensive statistical investigation. AUTHOR.

2257. *Atmospheric Attenuation of Ultra-Violet Light.* **E. R. Schaeffer.** (Am. Acad., Proc. 57. pp. 365–374, June, 1922.)—Photographs of the spectrum of a Cd spark in the interval λ 3500–2500 were taken from several stations where the air path ranged from 160 to 8000 metres. The apparent absorption for the shorter wave-lengths was very marked as the distance between the source and the spectrograph increased. A method of photographic photometry similar to that devised by Stetson to determine stellar magnitudes was used to measure the changes in relative intensities of the lines as the air path was increased. The values of the relative intensities of the spectral lines were plotted with the curve for molecular scattering computed from the Rayleigh formula. The results agree with Strutt's work in showing that the ozone concentration in the lower region of the atmosphere is negligible, but molecular scattering will not explain the magnitude of the effect as has been previously supposed. The absorption of light in this region of the spectrum by long columns of oxygen and loss by ionisation of the air may account for the observed attenuation. Over a hundred photographs of the ultra-violet spectrum of a Cd spark were taken at varying distances from the source. The spark between Cd terminals in parallel with a suitable capacity was produced by a ½-kw. transformer on a 60-cycle, 110-volt circuit. The apparatus for photographing the spectra consisted of an objective prism arrangement—a box containing a large 60° quartz prism, a quartz lens about 8 cm. in diameter of approximately one metre focal length, mounted behind the prism, and a holder for the photographic plate. A small telescope was attached permanently to the box to aid in getting the apparatus into line with the distant source. The adjustment was not changed until a number of photographs had been taken.

The investigations lead to the following conclusions:—1. It seems that the lower atmosphere is practically free from ozone. 2. Molecular scattering alone will not account for the attenuation of the shorter wavelengths from distant terrestrial sources. 3. Absorption by oxygen and ionisation of the air may explain the deviation from the curve for molecular scattering. 4. The isothermal layer of our atmosphere probably contains the ozone which sets the limit of the solar spectrum in the ultra-violet.

E. F.

2258. *Data for Cemented Objective of Barium Crown and Flint.* **I. C. Gardner.** (Optical Soc. America, J. 6. pp. 379–390, June, 1922.)—Gives extensive tables for the three radii of a cemented objective *f*/5 constructed of barium crown and barium flint glasses, having respectively $n = 1\cdot570$ to $1\cdot580$ and $1\cdot610$ to $1\cdot622$. The first set of tables gives the data for objectives corrected for spherical and chromatic aberration using a barium crown whose partial dispersion in relation to refractive index is shown in an auxiliary table. The second set of tables gives the data for objectives corrected for spherical aberration and sine condition. The amount of chromatic aberration present in these objectives is shown in an auxiliary table.

J. W. T. W.

2259. *On the Characteristics of Optical Systems for Reading Small Mirror Deflections.* **G. W. Moffitt.** (Optical Soc. America, J. 6. pp. 494–499, July, 1922.)—The shortcomings of the various deflection reading devices, in use with plane mirrors, are considered. The use of an ordinary small reading telescope leads to a restricted field of view, this being due to limitations in size of the mirror (which are necessary in order to reduce the moment of inertia of the moving parts), to limitation in the size of the objective, or to both these causes. The mirror limitations on image brightness cannot be eliminated, except by increasing the size of the mirror; but proper design of the telescope enables the visible field to be enlarged. A negative field lens in the ocular gives the best results if an ordinary telescope is used, but simply leaving out the field lens helps considerably, and many of the telescopes supplied with the better grade galvanometers are constructed in this way. To increase the length of scale visible in the field of view the size of the telescope may be increased, the focal length of the objective being made greater, the telescope advanced towards the mirror, so that the angle subtended at the mirror by the objective is increased, and the ocular modified to get the desired magnification and pupil position. It may not be necessary to increase the size of the objective to get this result. A correctly designed objective may be mounted on the galvanometer or other instrument, near the mirror, and a special ocular may be mounted on the scale support, so as to eliminate mirror and objective limitations of the field of view, and maintain the focus and freedom from parallax for large deflections. Some control can also be obtained, by proper design of the optical system, over the form of the calibration curve. The use of a large Kellner ocular is advocated, with simple lenses of about 10 cm. focal length, and separation such that crosswires can be dispensed with; cross lines ruled on the flat surface of the field lens being used instead. The field lens must be of considerable size; but may be narrow in the vertical direction, so that it does not obstruct the view of the central portion of the scale. A scale-reading device of this kind is also suitable for use with lamp and scale. H. N. A.

2260. *Schwarzschild's Sextant with Artificial Horizon.* **H. Chrétien.** (Rev. d'Optique, 1. pp. 232–235, May, 1922.)—A description is given of a sextant designed by Schwarzschild particularly for use in aircraft. The artificial horizon is provided by a spirit level, the air bubble in which is, by means of a collimator and fixed mirror, seen in the sextant telescope at the same time as the object under observation. The essential feature of the instrument is that the radius of curvature of the level is equal to the focal length of the collimator, so that the image of the air bubble reflected by the mirror at the top of the collimator is projected to infinity by its objective in the direction of the true horizon of the observer. The image of the bubble thus plays the same part as the horizon in the case of ordinary marine sextants. Diagrams are given to show the construction of the instrument, to which a weight is attached to facilitate balancing in a vertical position. A. W.

• **2261.** *Photometry of Optical Instruments.* **J. Guild.** (Optical Soc., Trans. 23. 3. pp. 205–216; Disc., 216, 1922.)—The use of a portable surface-brightness photometer of the polarisation type for the measurement of the fraction of the incident light transmitted by an optical instrument, or reflected by a mirror or system of mirrors, and for the measurement of the relative brightness of different parts of the field of view of an optical instrument, is described. The instrument employed is a Wanner optical pyrometer (Cambridge and Paul Inst. Co.) with some modifications to render it suitable for such work. An addition to the instrument is described which removes the danger of error due to polarisation of the incident light. AUTHOR.

2262. *The Nodal Slide as an Aid in Testing Photographic Lenses.* **T. Smith and J. S. Anderson.** (Optical Soc., Trans. 23. 3. pp. 188–196, 1922.)—The nodal slide is only convenient for the examination of lenses over their entire field when these are of normal type. Collimators and lenses should in general be directed to pass through all useful light as symmetrically about their axes as possible. Failure to secure this condition may lead to an underestimate of the excellence of good lenses as well as an underestimate of the gravity of the faults present in bad lenses. The nodal slide may with advantage be supplemented by suitable linkages, which enable all the special conveniences of the nodal slide to be retained. Some of the possible modifications are discussed. **Authors.**

2263. *Rotary Polarisation and Molecular Orientation.* **R. de Mallemann.** (Comptes Rendus, 175. pp. 151–154, July 17, 1922.)—This is a paper on the mathematical development of the theory according to Langevin and recently verified by Pauthenier. The theory of orientation is extended to the case of molecules optically active, as the rotary power is found to depend upon parameters connected to each kind of molecule and functions of their respective dissymmetry. If an electron attached to an atom is considered, the forces acting on this electron depend on the nature of the internal luminous field to the body h' and on the structure of the atom, and these forces can vary with the direction of propagation of the wave. The equations of moment of an electron with respect to the molecular axes are given, and the conclusion obtained that the medium propagates, without deformation, with different speeds, two circular deadened waves of opposite directions. T. C. H.

2264. *Huyghens's Contributions to Dioptrics.* **J. P. C. Southall.** (Optical Soc. America, J. 6. pp. 461–475, July, 1922.)—An interesting annotated résumé of some of Huyghens's results, of very modern character. [*Remark.*—In his annotations the author writes the well-known criterion that for an aplanatic surface for rays from a source J to converge upon a point J′ in a second medium of relative refractive index n, the reduced path from J to J′ through any point P of the surface is constant, or $n\,.\,(\mathrm{PJ}') + (\mathrm{PJ}) = \text{const.}$, as $n\,.\,(\mathrm{PJ}') - (\mathrm{PJ}) = \text{const.}$, and from this he deduces that when const. = 0 the aplanatic surface is a sphere.] A. D.

2265. *Theory of Intermittent Vision.* **H. E. Ives.** (Optical Soc. America, J. 6. pp. 343–361, June, 1922.)—The author first reviews conclusions derived from the work of previous experimenters. Among the most important are :—(1) For all wave forms critical frequencies plot against logarithms of illumination as parallel straight lines. (2) If flicker range is varied the amplitude enters as a multiplier of illumination. (3) If ratio of exposure to obscuration is varied the critical speeds are approximately the same for complementary openings. These relations may be expressed in mathematical form. At very low intensities, using short-wave radiation, critical speeds are independent of intensity and vary only with wave form. The author next discusses previous theoretical treatments of the problem, and endeavours to frame a theory of visual response which would lead to the established critical frequency relationships. Three steps in the process of perception of flicker are assumed : —(1) A photochemical reversible action such that the equilibrium value under steady illumination is proportional to the logarithm of the stimulus ; (2) a conduction process, according to the Fourier diffusion law ; (3) a perception process such that the time rate of change of transmitted reaction must exceed a certain critical value. The theory is developed mathematically, and the conclusions to which it leads are illustrated by numerous diagrams. The most serious objection to the theory is that the logarithmic relation between illumination and critical frequency is due to the special type of conduction process assumed; it is more likely to be a consequence of the logarithmic relation between stimulus and response. In addition, the processes assumed may appear somewhat complex though this impression is due to the mathematical treatment rather than to the processes which are themselves simple and plausible. J. S. D.

2266. *New Radiation of Short Wave-Length.* **G. Reboul.** (Comptes Rendus, 174. pp. 1451–1453, June 6, 1922.)—A description has previously been given [Abs. 556 (1922)] of experiments proving the existence of radiation of short wave-length in the case of a badly conducting substance traversed by an electric current, and it was shown how the wave-length could be found. Further experiments with regard to the absorption of the rays by celluloid have shown them to have wave-lengths of the order of 300 to 350 Å.U., and consequently they belong to the ultra-violet region studied by Millikan. The principal property of the rays is the ease with which they are absorbed by all substances. The coefficient of absorption for air is about 15. For celluloid it approximates to $1{\cdot}7 \times 10^5$, while for fluorine it is about 105. With the same apparatus and different experimental conditions, radiations have been obtained which are not so easily absorbed as the above, and which belong to that part of the ultra-violet studied by Lyman. A. W.

2267. *Refraction of a Pencil of Light.* **Dufour.** (Comptes Rendus, 174. pp. 1539–1541, June 12, 1922.)—Describes a method for obtaining the three equations defining the refracted pencil in the general case of refraction at a surface. J. W. T. W.

2268. *Molecular Birefringence and Optical Activity.* **R. de Mallemann.** (Comptes Rendus, 175. pp. 263–265, July 31, 1922.)—This mathematical paper first considers rotatory power, which a previous investigation has shown to be a function of the molecular coefficients of optical activity; next the refractive index receives attention under the assumption of isotropic rotatory power; finally, birefringence is examined, and a method indicated for obtaining information on the nature of the true rotatory power of the molecule. H. H. Ho.

2269. *Explanation of Interference-Curves of Uniaxial and Biaxial Crystals by Superposition of Elliptic Pencils.* III. **J. W. N. Le Heux.** (K. Akad. Amsterdam, Proc. 25. 3 and 4. pp. 81–86, 1922.)—A continuation of previous work [Abs. 1984 (1922)]. The present paper explains how hyperbolas, lemniscates, etc., may be obtained by the superposition of sets of ellipses. Superposed harmonograms are used in illustration. A. W.

2270. *Quantum Theory of Photographic Exposure.* **L. Silberstein.** (Eastman Kodak Co. Research Lab. Comm. No. 139. Phil. Mag. 44. pp. 257–273, July, 1922. Paper read before combined meeting Am. Phys. Soc. and Am. Assoc. Adv. Sci., Toronto, Dec. 28, 1921.)—Assume (1) that the necessary and sufficient condition for a silver-halide grain to be *affected*, i.e. to be made developable (entirely or in part), is that it should *absorb one light-quantum*; and (2) that a grain does absorb a light quantum *whenever it is fully hit by one* of a sufficiently high frequency or of a wave-length not exceeding a certain value λ_c, the critical wave-length as known from Photo-Electricity. It follows that if the grains be equal in size $k = N(1 - e^{-na})$, where k is the number of grains hit, N is the number of grains in area S, n is the number of light-quanta reaching S, and $a = \{(\text{area of each granule})/S\}$. More rigorous deduction, if $m = Na \cdot n$, gives the general expression $1 - (k/N) = \{1 - (1/N)\}^m$, which degenerates to the former expression when N is large. The expression, $k = N(1 - e^{-na})$ when N is large, applies to each size of grain separately; hence, for $N = f(a)$, $k_a = f(a)(1 - e^{-na})$, to be summed up for all sizes a of grain. But, quantum theory, $n = (\alpha/hc)E\lambda$. Therefore k_a will, for constant E and α (α probably = 1), increase with λ up to the critical λ_c and then drop abruptly to zero. The experimental curve is an aggregate for a whole range of grain-sizes a; and it drops gradually to zero. This may be explained (*a*) by different grain sizes a having different critical λ_c's, or (*b*) by possible finite transversal dimensions of the light-parcels or quanta, assuming that a quantum becomes efficient in affecting a grain only if it strikes it fully or almost so; or (*a*) and (*b*) may be related to one another. The number of developable particles, k, would therefore depend on the grain size a; i.e. the larger the grains the greater the "speed" of the plate. Experimentally, a weak light for a short time affects a limited number of grains; which favours a quantum distribution of energy in the incident light; the discrete light-quanta hit now this, now that grain of halide. The numerical results of Trivelli and Righter confirm the foregoing formulæ, on the basis that a clump of grains acts and becomes wholly developable as if it were one grain [see next Abstract]. A. D.

2271. *Preliminary Investigations on Silberstein's Quantum Theory of Photographic Exposure.* **A. P. H. Trivelli** and **L. Righter.** (Eastman Kodak Co.'s Research Lab. Comm. No. 141. Phil. Mag. 44. pp. 252–256, July, 1922.)—Preliminary experimental data, which confirm the theory on the basis mentioned in the preceding abstract. A. D.

2272. *On Variations of the Critical Opalescence with the Tube Charge and the Nature of the Liquid Studied.* **A. Andant.** (Comptes Rendus, 174. pp. 1541–1543, June 12, 1922.)—This subject has been partly dealt with in a previous note [see Abs. 2082 (1922)], where the critical opalescence was shown to vary with temperature and with the wave-length of the incident light. The present paper investigates the influence of the tube charge and the nature of the liquid. The conditions chosen were falling temperature and monochromatic light. Experimental details are briefly described. Section I considers the influence of tube charge, the latter being defined by the ratio D at 18° C. of the liquid volume to that of the vapour contained in the tube. The temperature T'_c of meniscus return in a Natterer-tube is found to be a parabolic function of D, and for ether between the values 0·42 and 0·71 can be expressed by the equation, $T'_c = 190°, 04 + 12{\cdot}75D - 12{\cdot}50D^2$. From the curves showing variation of opalescence with temperature, there exists between T'_c and the temperature of maximum intensity T_M a variation whose value passes through a minimum (0·02°) for charges near to 0·50. For ether, where D = 0·42, the opalescence commences at 1·5° before the maximum. Section II deals with the influence of the nature of the liquid, and gives the results of a systematic study of the relative opalescences of the 4 acetates of methyl, ethyl, butyl, and isobutyl in tubes having the same charge and near to 0·50. The two latter liquids, which are isomers, show no differences, but the opalescence is appreciably more intense and its extent more pronounced in passing from the first to the fourth of the above series. Within 0·20° of the temperature of maximum intensity the intensities are sensibly proportional to the squares of the molecular weights, but in the immediate neighbourhood of the critical point this relationship is no longer valid. In the previous paper, the regular variation of opalescence with temperature and wave-length experiences a strong perturbation in the immediate vicinity of the critical temperature, and this is also found to occur for the variation with the nature of liquid taken. The idea is thus confirmed that true opalescence must be distinguished from the phenomena of the critical point.

H. H. Ho.

2273. *Fluorescence and Electron Emission.* **J. Franck.** (Zeits. f. Physik, 9. 5. pp. 259–266, 1922.)—Deals with some conclusions which can be drawn from the theory of Klein and Rosseland.

2274. *Spectral Study of the Triboluminescence of Saccharose.* **H. Longchambon.** (Comptes Rendus, 174. pp. 1633–1634, June 19, 1922.)—The spectrum obtained when saccharose is broken, in the air and at the ordinary pressure, before the slit of a spectrograph is discontinuous, and is composed of almost all the constituents of the second positive band spectrum of nitrogen and of these only. The triboluminescence of saccharose is, therefore, due to a discharge taking place in the air between two solid particles which have just been suddenly separated and are electrically charged. This appearance of electric charges is not surprising in view of the pyro-electric properties of the sugar, although it cannot be stated that the triboluminescence is itself a pyro-electric effect. The luminosity is greatly increased if the rupture of the saccharose is carried out at a pressure between 4 and 0·1 cm. Triboluminescence is observed also when the air in a partially evacuated tube containing sugar finely powdered by vigorous agitation is subjected to sudden compression or expansion.

T. H. P.

2275. *Vacuum Hot-Spark Spectrum of Zinc in the Extreme Ultra-Violet Region.* **R. A. Sawyer.** (Astrophys. J. 52. pp. 286–300, Dec., 1920.)

2276. *On the Curve of Energy Distribution in the Ultra-Violet Part of the Solar Spectrum.* **C. Fabry and H. Buisson.** (Comptes Rendus, 175. pp. 156–159, July 17, 1922.)—Difficulties attending the direct thermometric measurement of the energy distribution in a continuous spectrum explain how the energy curve is not well established in the region of short wave-lengths where feeble energy is accompanied by a strong atmospheric absorption. Abbot's measurements, the most complete of those on the solar spectrum, are very uncertain in this region. The present authors have employed a less direct method, but one more easy of application, whose principle is to utilise a comparative source of known energy curve. Few researches are available, the best being those of Coblentz on the acetylene flame and these unfortunately do not extend to the ultra-violet. Fortunately, however, the radiation law of the black body is now well known, and the properties of various solid bodies are such that their radiation is sensibly identical with that of a black body. As a comparison source the positive crater of the electric arc has been taken whose absolute temperature is 3750°. Comparison between the solar and arc spectra has been made by photograph. A brief discussion of experimental procedure is given, and a table of results included for wave-lengths ranging from 3940 to 2922. In the observable limit of the solar spectrum, the energy curve approaches that of a black body at 6000°. The energy of this part of the spectrum before its absorption by the atmosphere is considerable, and much greater than Abbot assumed. For $\lambda = 2922$, the atmosphere traversed vertically only allows 1/70000th of the incident radiation to pass. Below 2900 observation becomes impossible on account of atmospheric absorption. Abs. 1288 (1922) should be consulted. H. H. Ho.

2277. *Ionisation and Absorption Effects in the Electric Furnace.* **A. S. King.** (Nat. Acad. Sci., Proc. 8. pp. 123–125, June, 1922.)—Fowler [Abs. 1680 (1914)] has shown that the Rydberg constant N occurring in the formulæ for arc lines is changed to 4N for enhanced lines. The condition pictured by Bohr's theory is that the enhanced lines are produced by atoms which have lost one electron, while the normal atom emits the arc lines. Recent work by Saha [Abs. 90 (1922)] applies the relations recognised in physical chemistry to the case when the normal atom is changed into an ionised atom with an electron set free. A definite equilibrium is considered as established, represented in the case of calcium by $\mathrm{Ca} \rightleftarrows \mathrm{Ca}^{+} + e$. It follows from this that if we add a large supply of electrons from some substance which becomes ionised more readily than calcium, fewer electrons from the calcium can exist in the free state, and the proportion of Ca^{+} atoms becomes less, with a corresponding weakening of the enhanced lines relative to the lines of the normal spectrum. In the electric furnace, the enhanced lines of some substances can be produced faintly [Abs. 1064 (1921)], and the effect of a mixture with an easily ionised substance may be tested, under the same conditions of temperature and pressure for the mixture as for the pure substance. Experiments have been carried out in which both emission and absorption spectra were compared in this way.

The spectra of calcium and strontium showed in each case a decided weakening of the enhanced lines when a mixture of either element with potassium or cæsium was examined, while the arc lines were unaffected. Sodium, whose ionisation potential is nearly the same as that of barium, produced no weaking of the barium enhanced lines. The experiments thus support the view of an equilibrium between electrons and ionised atoms, which may be disturbed by an added supply of electrons. Certain experiments showed that the iron spectrum showed no decided difference between the emission and absorption spectra at the same temperature, except as to the production of the ultra-violet spectrum. For the emission spectrum a definite limit is set by the black-body radiation at that temperature, but the vapour is able to absorb radiation of much shorter wave-length. One feature of Saha's theory is that a vapour too cool to emit should be able to absorb the lines of the principal series. This was tried with the strong flame lines λ4227, λ4607, and λ5535 of calcium, strontium, and barium respectively. In each case a temperature was found at which no emission could be detected, but when white light was sent through the furnace the lines appeared distinctly in absorption. For these favourable lines the view of Saha is thus confirmed. Other experiments showed that a high temperature is required to produce the subordinate series absorption lines. The general character of the absorption phenomena in the furnace may be described as in general a reversal, when white light is passed through the tube, of the emission spectrum at the same temperature. Exceptions are found in the easily excited principal series lines, and perhaps others, which the vapour can absorb before it emits, and in the ultra-violet region beyond the limit, at the given temperature, of the black-body radiation. In the latter case an absorption spectrum appears beyond the emission limit when a sufficiently hot source of white light is employed. A. W.

2278. *Connection between the Spectra of Ionised Potassium and Argon.* I. **P. Zeeman** and **H. W. J. Dik.** (K. Akad. Amsterdam, Proc. 25. 3 and 4. pp. 67–80, 1922.)—Kossel and Sommerfeld [Abs. 1201 (1919)] have given a displacement law connecting the spark spectrum of an element with the arc spectrum of the element preceding it in the periodic system. Thus there should be a connection between the spectra of ionised potassium and argon, since on the Rutherford-Bohr conception of the atom the electron system obtained when a potassium atom loses one electron must closely resemble that of argon. New measurements have been made of the lines of the spark spectrum of ionised potassium, and a wave-length table is given. It is found that the lines observed show regularities similar to those observed by Rydberg in the red spectrum of argon, sets of lines with constant frequency differences being obtained. Thus, while the relations for argon are $B = A + 846\cdot1$, $C = A + 1649\cdot3$, $D = A + 2256\cdot1$, those found for ionised potassium are $Q = P + 847$, $R = P + 1695$, $S = P + 2542$. It thus appears that the first spark spectrum of potassium is somewhat simpler than the red spectrum of argon, the frequency differences being 847, 2 × 847·5, 3 × 847·3.
A. W.

2279. *Errors Arising in the Measurement of Unsymmetrical Spectrum Lines.* **T. R. Merton** and **D. N. Harrison.** (Roy. Soc., Proc. 101. pp. 431–434, Aug. 1, 1922.)—In a previous paper [Abs. 866 (1921)] the limitation which the resolving power of a spectroscope imposes on the accuracy of wave-length determinations of unsymmetrical lines was considered. The present paper discusses the effect of "drift" of the spectrum under examination across the photographic plate owing to mechanical displacement of the apparatus, or varying temperature, or other cause. It is shown that appreciable errors in wave-length measurements of unsymmetrical lines may arise in this way. A. W.

2280. *False Spectra from Diffraction Gratings.* I. *Secondary Spectra.* **W. F. Meggers** and **C. C. Kiess.** II. *Theory of Lyman Ghosts.* **C. Runge.** III. *Periodic Errors in Ruling Machines.* **J. A. Anderson.** (Optical Soc. America, J. 6. pp. 417–442, July, 1922.)—In the first of these papers a detailed description is given of an investigation of secondary spectra (Rowland and Lyman ghosts) shown by two 6-inch curved gratings ruled by Anderson on Rowland's machine, and by two other gratings ruled on a different machine. The second paper gives a complete analysis which explains the Lyman ghosts as due to a double periodic error in the ruling of the gratings. In the third paper Anderson discusses the probable sources of such periodic errors in ruling machines. In the case of five gratings ruled on Rowland's 15,000 machine, observations have shown the existence of a double periodic error, the short period error in each case having the same value 5, while the long period error varies between 277 and 348. The recurrence of the same short period error is probably connected with the fact that the driving belt of the machine makes 2 revolutions for each 5 cycles of the machine, and the upward pull exerted by the belt on the machine may vary somewhat if the belt is not of uniform thickness, owing to the small diameter (2 inches) of the driving pulley. Slight variations in the length of the belt due to stretching with use might explain the variations in the length of the longer period observed. **A. W.**

2281. *On the Variations of the Arc Spectrum of Mercury with the Conditions of Emission.* **St. Procopiu.** (Comptes Rendus, 175. pp. 217–219, July 24, 1922.)—Gramont and Hemsalech have drawn attention to the variations of the arc spectra of metals with low fusion points, when the arc is formed between the metals themselves, wet or dry, and not between carbons containing the metals. The chief difference is in the appearance of spark lines [Abs. 1981 (1921)]. Procopiu has studied the mercury arc *in vacuo*, using a quartz lamp. For the arc in various media two concentric tubes containing mercury have been used, the inner one being of quartz. With the vacuum arc, using small currents and voltages, the arc only lasts a short time, and can only be re-established when the lamp has cooled. By starting it a number of times, however, it is possible to photograph the spectrum, which contains more rays towards the extremity of the ultra-violet, up to 2191, than when a lamp has been burning for one or two hours, with a high voltage and current, and the density of the mercury vapour is large. In both classes of spectrum the kathode spectrum has more lines than that of the anode, and in the second class the kathode lines become diffuse, and sometimes are drowned in a continuous spectrum.

In air, water, and, above all, in coal gas the triplets of the two secondary series are affected. The triplets 5460, 4358, 4046 (II secondary or sharp series, $m = 1$), 3341, 2893, 2752 (II, $m = 2$), and 3663–3650 (I secondary or diffuse series, $m = 2$) are not sensibly affected. The terms of a somewhat higher order are much widened and enfeebled, the line towards the violet being most broadened. The last terms of the series (II, $m = 4$), (II, $m = 5$), (II, $m = 6$), (II, $m = 7$), (I, $m = 4$), (I, $m = 5$), (I, $m = 6$), and (I, $m = 7$) disappear completely. Line 2537 is reversed in air, water and coal gas, with a hot arc. Some lines become stronger in these three media; amongst others the strong lines 2848 and 2224, which are attributed to Hg^+.

The facts seem to be related to Bohr's theory, and to the Stark effect. The high order lines in a series are due to large orbits, and can only be produced if the space between molecules is sufficient, as will be the case in the low current vacuum arc, and before the lamp has got hot and the vapour dense. The broadening of the rays may be due to an intermolecular electric field. A field has a greater effect as the position of the line in a series becomes higher. The same hypothesis may explain the broadening of the lines near the kathode, since here there is strong ionisation, due to shock, and so a strong intermolecular electric field. It appears

then, that to obtain missing terms in the spectral series of metals the arc should be formed *in vacuo*, and with as small a current as possible.
H. N. A.

2282. *A Contribution to the Inauguration of a System of International Standard Wave-lengths.* **F. Müller.** (Zeits. wiss. Phot. 22. pp. 1–20, June, 1922.)—The paper contains data of standard wave-lengths which are reliable to the third decimal place. In the experimental investigations a series of error sources have been found which influenced the second decimal place of previous values, and certain groups of iron lines were discovered to be only accurate to the third place under special experimental arrangements for the electric arc. The pole effect is responsible for a displacement of lines in various parts of the spectrum, and reference is made to the work of Gale, Adams, St. John, Ware, and Babcock in this connection. St. John and Babcock, in attempting to eliminate the pole effect from the source for secondary standards of wave-length, found that the disturbance was completely removed if a horizontal zone (only 1½ mm. wide) of a vertically installed 12-mm. long arc be used as a source of light with a current of under 5 amperes. The work of the 1919 Committee on Standards of wave-length of the International Research Council at Brussels is briefly described, and prominent gaps in the green-yellow and lack of standards in the ultra-violet referred to. The author's own researches are then detailed. Section 2 describes the experimental arrangements adopted, and section 3 the various conditions adopted to secure a relationship between line width and intensity. Section 4 contains a record of measurements with very complete tables of data. The paper concludes with a criticism of international standards in the region 4531–5658.
H. H. Ho.

2283. *Simple Monochromator for* 200 *to* 750 $\mu\mu$. **C. Leiss.** (Zeits. f. Physik, 10. 6. pp. 399–402, 1922.)—Describes a monochromator for use in the visible and ultra-violet. The prism system is so arranged that alteration of wave-length is achieved without change of deviation, the constant angle between the collimator and telescope being 128°. The prisms are of such a size that the whole aperture of the objective (30 mm.) is used. The construction of a smaller model, and of a large model for high illumination is described in the paper. Details of dispersion are also given, and the method of calibration is indicated.
J. W. T. W.

2284. *Spectra of Sparks in Water.* **L.** and **E. Bloch.** (Comptes Rendus, 174. pp. 1456–1457, June 6, 1922.)—A systematic study was made of the spark spectra under water of the following metals: Ca, Mg, Al, Tl, Cu, Ag, Fe, Sn, Pb, Sb, and Bi. The region dealt with was from 2200 to 5000 Å.U., and the optical and electrical arrangements were the same throughout. An oscillating spark was used, the frequency being in the neighbourhood of 570,000. The observations agree with the results obtained by earlier workers in certain respects, but in many other points correct or extend them. (1) The intense continuous spectrum which accompanies the production of sparks in water, and which appears nearly independent of the metal used, becomes attenuated, and finally disappears as the frequency is progressively diminished. The spectrum appears to be due to hydrogen, and has its origin in the centre of the spark. (2) The metallic lines are sharply divided into two classes:

(*a*) the black lines or lines of emission, and (*b*) the reversed lines or absorption lines. The black lines, which exhibit the Stark effect, also originate from the central part of the spark, while the reversed lines are due to absorption by the layer of vapour surrounding the spark. (3) Increase of the self-induction causes the continuous spectrum to disappear, and at the same time causes lines at first reversed to appear as emission lines. (4) As a general rule, the emission lines are all "spark" lines, while the reversed lines are "arc" lines. Certain very strong spark lines, however, such as some of the Ca and Mg lines, may appear partially reversed, while certain arc lines (Zn, Hg) are sometimes reversed, and at other times emitted. (5) In the spark in water some arc lines (reversed) appear which do not exist, or exist very faintly in the spark in air. The spark spectrum of iron in water, for instance, gives by its reversed lines the "negative" of the ordinary iron arc spectrum. (6) The spark spectra in water give with exceptional sharpness and intensity among the reversed lines the characteristic lines of the flame spectra (de Watteville). These are the $1S - 1p_2$ lines of Zn, Cd, and Hg ($\lambda\lambda$3076, 3261, 2536), the $1S - 1P$ lines of Ca and Mg ($\lambda\lambda$4227, 2852), etc. Generally speaking there is a complete analogy between the spectra of reversed lines of the under-water spark and the flame spectra studied by de Watteville. The under-water spark furnishes a ready means of discriminating between arc and spark lines, and so facilitates the investigation of spectral regularities. From photographs of the spectra of tin four doublets have been found with constant frequency difference about 625, and in the spectrum of copper several new combinations have been found. A. W.

2285. *A Non-polarising Spectrophotometer.* **A. J. Bull.** (Optical Soc., Trans. 23. 3. pp. 197–202; Disc., 203–204, 1922.)—The paper deals with a form of spectrophotometer in which uniform monochromatic patches of colour are compared, instead of the more usual arrangement of two portions of a spectrum. A spectrum is arranged so that the upper half has undergone selective absorption by the material under test, and a narrow region of the spectrum is selected by a slit. A split lens then forms two images of the dispersing prism face. These images are brought into juxtaposition by means of a rhomb-like prism with slightly unequal angles, which corrects the divergence of the two beams produced by the split lens. Photometric balance is secured by the partial closure of the lower portion of the selecting slit. AUTHOR.

2286. *On the Masses of Particles which Emit the Spectrum of Carbon Monoxide.* **M. Duffieux.** (Comptes Rendus, 175. pp. 159–161, July 17, 1922.)—Assuming that the width of the spectral pencil emitted by a luminous gas is entirely due to thermal movement, the limiting order of the interference fringes which may be obtained from these rays is given by the formula, $N = k\sqrt{M/T}$, where T is the absolute temperature of the gas, M the mass of the luminous particles, and k a numerical coefficient. This formula has been utilised by several workers for the determination of M [see Abs. 1256 (1915)], and the present author now applies the method for investigating the origin of the spectra of nitrogen and carbon monoxide. Experimental arrangements are briefly described. For nitrogen the results obtained confirm those of Hamy, N being found between 240,000 and 280,000, which has enabled a conclusion to be drawn that the bands of the second positive group of nitrogen are due to the atom, M = 14. In the spectrum of carbon monoxide, one band is emitted by carbon and 4 others by the atom of oxygen, M = 16. Such bands cannot be attributed to the complete molecule of carbon monoxide, but to its decomposition products, viz. the free atoms of carbon and oxygen. The spectra thus appear to be those in part of the individual atoms. H. H. Ho.

2287. *Sharp Spectral Lines with Short Exposures by the Debye-Scherrer Method.* **H. Küstner.** (Phys. Zeits. 23. pp. 257–262, July 1, 1922.)—The author describes a new experimental arrangement whereby it is possible to employ a wide-angle X-ray beam to radiate a cylinder of crystal powder (Debye-Scherrer method) and yet obtain very sharp spectral lines. Good photographs have been obtained even with very short exposures. A. B. W.

2288. *Difference between Series Spectra of Isotopes.* **P. Ehrenfest.** (Nature, 109. pp. 745–746, June 10, 1922.)—It appears to Ehrenfest that it is not certain what should be theoretically expected in the case of the spectra of isotopes. Bohr's formula for the change in the frequency v due to the motion of the nucleus has been applied by him only to the cases in which a *single electron* moves around the nucleus, namely, to H and He^+. Recently the formula has been also applied by various authors to the calculation of the difference between series spectra of isotopes; this means to atoms in which *several electrons* move around the nucleus. There appear to be as yet no investigations of the equation which must for these cases replace Bohr's equation

$$v_2 : v_1 = \left\{M_2/(M_2 + m)\right\} : \left\{M_1/(M_1 + m)\right\} \ldots (1),$$

where M_1, M_2, m are respectively the masses of the nuclei of the isotopes and of the electron, v_1, v_2 being the frequencies of corresponding lines. For the case of one electron only, equation (1) follows immediately from the well-known transformation of the "problem of two bodies" from absolute to relative coordinates. For several electrons there is no similar simple transformation. The "radiating" electron compels the remaining electrons to execute motions of reaction, which also influence the nucleus. It may be possible to derive a sufficiently approximate formula for the case of the *p*- and *d*-motions of lithium. This must, however, be very difficult for the case of the 1·5 S path. An example is given to show that at all events equation (1) cannot be true in general for atoms with several electrons.

N. Bohr (*ibid.*) assumes that the electron connected with the emission of the series spectra, although during the larger part of the revolution it remains outside the configuration of the electrons in inner groups, will nevertheless in certain states penetrate into the interior of the atom during its revolution [see Abs. 1212 (1921) and 266 (1922)]. The fact that the electron in the inner loop of its orbit is subject to large forces is of preponderant influence as regards the fixation of the energy in the corresponding stationary states of the atom. For such a motion the effect of the nuclear mass might differ essentially from that estimated from an examination of the mechanical properties of the motion in the outer loop only, and the question arises whether the mass effect is sufficiently large to account for the discrepancies observed by Merton in the wave-lengths of certain lines in the spectra of lead isotopes, which although very small, are yet much larger than those to be expected from the simple formula (equation (1)) quoted by Ehrenfest. This question seems difficult to settle without a closer investigation, but it would scarcely appear probable that the answer will be affirmative. The penetration of the series electron deeply into the atom during a short interval of its revolution may possibly be of great importance. A. W.

2289. *X-Ray Electrons.* **R. Whiddington.** (Phil. Mag. 43. pp. 1116–1126, June, 1922.)—When X-rays are incident on the surface of any material high-speed electrons are ejected. The speed of such electrons was first measured by Dorn in 1900 and Innes in 1907, and it appeared from their results that the speed lay between 6 and 8 × 10^9 cm./sec., and was independent of the intensity of the X-rays. Later experiments by the author, however, in 1912 (Proc. Roy. Soc.) showed that the ejection speed was nearly equal to 10^8 A, where A is the atomic weight of the element supplying the X-rays. The method employed in reaching this result, was, however, only approximate and the present work was undertaken with an improved arrangement to obtain more extended results.
A. B. W.

2290. *Characteristic X-Rays from Carbon and Boron.* **J. Holtsmark.** (Phys. Zeits. 23. pp. 252–255, June 15, 1922.)—The author has determined experimentally the critical voltage necessary to excite the k_a radiation in carbon and boron. For carbon 285–290 volts, and for boron 145–150 volts are given as reliable values, corresponding to wave-lengths:

Carbon	42·9 Å.U.
Boron	83·6 Å.U.

A. B. W.

2291. *Reflection of X-Rays by Crystals.* **R. Darbord.** (J. de Physique et le Radium, 3. pp. 218–220, June, 1922.)—Considerations relating to the laws of reflection of X-rays from crystalline surfaces. A. B. W.

2292. *Direct Determination of the Wave-length of X-Rays.* **R. Darbord.** (J. de Physique et le Radium, 3. pp. 212–217, June, 1922.)—The method described involves the reflection of a beam of monochromatic X-rays from two crystal surfaces in succession; the two surfaces being slightly inclined (at angle θ) to each other. Two reflected beams are received on the photographic plate, inclined to each other at an angle θ, which results in a phenomenon of partial interference—analogous to Fresnel mirrors in parallel light. The author calculates the separation of the interference bands and thence calculates the wave-length of the X-rays.
A. B. W.

RADIO-ACTIVITY.

2293. *β- and γ-Ray Emission on the Quantum Theory.* **A. Smekal.** (Zeits. f. Physik, 10. 5. pp. 275–302, 1922.)—A theoretical paper not suitable for concise abstraction. The author deals with the problem of radio-active disintegration on the basis of the quantum theory and makes certain deductions relating to the nuclear structure of the atom. A. B. W.

2294. *Attempt to Influence the Random Direction of a-Particle Emission.* **G. H. Henderson.** (Cambridge Phil. Soc., Proc. 21. pp. 56–58, May, 1922.) —In a recent paper by J. L. Glasson (Camb. Phil. Soc. Proc. xxi. p. 7, 1921) attention was drawn to some peculiarities in the ionisation photographs of C. T. R. Wilson, depicting the α-ray tracks due to radium emanation which was diffused throughout the expansion chamber. It was pointed out that there seems to be a tendency for all the α-ray tracks to point in definite directions. It was suggested by Glasson that such an effect was unlikely to be due to chance, but might be explained by assuming that the α-particles were emitted from the emanation nucleus in a definite direction, the emanation atoms themselves being oriented by some force, possibly a magnetic field. The author has tested this suggestion experimentally and concludes that it is quite impossible for this to be true. A magnetic field of the order suggested by Glasson is quite unable to produce any appreciable influence on the distributions of α-ray tracks, and the cause of such distributions as those to which attention is called, if not due to chance, must be looked for elsewhere. The possible effect of an electric field was also looked for, but in this case also the result was negative. A. B. W.

2295. *Number of α-Particles Emitted from Thorium C.* **A. G. Shenstone** and **H. Schlundt.** (Phil. Mag. 43. pp. 1038–1047, June, 1922.)—A description is given of an experimental determination of the number of α-particles emitted per second by thorium C of known γ-ray activity. Since that number is known for radium C, a direct comparison by counting and by activity of radium C and thorium C will fix the number of α-particles emitted per second per milligram of ThC. The final ratio of α-particles emitted from ThC to α-particles emitted from RaC for equal γ-activities was found to be 0·75. Thorium C of γ-activity equivalent to 1 mg. of radium emits $3{\cdot}07 \times 10^7$ α-particles per second. A. B. W.

2296. *Preparation of a Standard Radiferous Salt.* **Yovanovitch** and **[Mlle] Chamié.** (Comptes Rendus, 175. pp. 266–268, July 31, 1922.) —The preparation of a radio-active standard solution for the determination of the relative small amounts of radium in minerals is not easy owing to the tendency towards formation of insoluble deposits from the solution. The attempt is here recorded for the preparation of a solid standard. Radiferous barium chloride was first tested, but found unsatisfactory, and recourse was had to the insoluble and non-hygroscopic carbonate. Methods for the preparation of the latter are included, with illustrative diagram of the apparatus employed. Data are given showing that a standard content of radium can be secured by the method described to 0·5 %. H. H. Ho.

2297. *An Apparatus for Demonstrating the Electrical Properties of Conducting Gases.* **J. Zeleny.** (Optical Soc. America, J. 6. pp. 521–523, July, 1922.)—Air is blown over radio-active material, held in a tube of adjustable length, at the other end of which is an insulated electrode, connected with an oscillating leaf electroscope. The rate of motion of the leaf diminishes when the distance between the radio-active material and the electrode is increased; and as the conductivity at the electrode is diminished, owing to the increased recombination of ions over a longer path. The loss of conductivity by passing the air through glass wool, or through the narrow channels between a bundle of metal wires, can also be shown; or the ions can be removed, before the air reaches the main electrode, by passing it near a second electrode, at a different potential from that of the surrounding tube. This arrangement can also be used to measure the mobilities of the two ions, by measuring the mean velocity of the gas stream, and applying different voltages to the second electrode, until one is found which just permits some of the ions to reach the electrode connected with the gold leaf of the electroscope. H. N. A.

2298. *The Velocity of the α-Rays of Polonium.* **I[rene] Curie.** (Comptes Rendus, 175. pp. 220–222, July 24, 1922.)—This velocity can be obtained from that found for RaC by Rutherford and Robinson [Abs. 310 (1915)] by making use of Geiger's law, which states that the range is proportional to the cube of the velocity. It has been determined directly by the method of magnetic deviation; the polonium used being separated from RaD by electrolysis, and deposited on a silver plate. Two control photographs were made with the polonium activated by radium emanation, thus obtaining lines due to RaC, in addition to those due to polonium. Since the α-particles pass through two fine parallel slits, fine lines are produced on the photographic plate, and the deviations can be measured very exactly. The value obtained for the velocity of the polonium α-rays is $1\cdot593 \times 10^9$ cm. per sec. The ratio of the velocities of the α-rays of polonium and of radium C is $\frac{1\cdot593 \times 10^9}{1\cdot922 \times 10^9} = 0\cdot819$. The most recent values of the ranges of the α-rays of these substances are, polonium 3·925 cm., RaC 6·971 cm. The cube root of the ratio of these numbers is 0·826, which is within 0·36 per cent. of that of the velocities. H. N. A.

2299. *Precipitation of Uranium Nitrate by Sodium. Radio-activity of the Precipitate.* **P. Jolibois** and **R. Bossuet.** (Comptes Rendus, 174. pp. 1625–1628, June 19, 1922.)—An experimental study of the conditions favourable to precipitation of uranium nitrate by means of sodium. The radio-activity of the precipitate has been determined and found to be quite normal. A. B. W.

2300. *Direct Measurement of Small Quantities of Radium.* **B. Szilard.** (Comptes Rendus, 174. pp. 1695–1698, June 26, 1922.)—The author describes a novel form of portable electrometer which is designed primarily for the measurement of small quantities of radium by means of the penetrating γ-radiation. A. B. W.

HEAT.

2301. *Thermostats with Multiple Walls.* **A. Tian.** (Comptes Rendus, 174. pp. 1453–1455, June 6, 1922.)—In the multiple-wall thermostats here described the central enclosure is of copper covered all over its outside surface with felt. This is enclosed again in one or more boxes, also made of copper and packed round with felt. The outside box receives the heating and dissipates the heat, and must be in very good calorific relation to the thermo-regulator. This is secured by immersing the latter in a bath of mercury which is in good contact with the outside box. Thermostats thus constructed have several advantages over the ordinary type. (1) The damping out of thermal oscillations due to variations of the regulator is practically complete. With three enclosures the amplitude of such oscillations is reduced in the central enclosure to less than one-thousandth. (2) The temperature of the thermostatic bath remains uniform even though the surrounding temperature may vary several dozen degrees, so that the bath temperature is practically independent of the temperature of the surroundings. (3) With these thermostats there is no necessity to employ any stirring whatever. A. W.

2302. *The Ratio of the Calorie at 73° to that at* 20° C. **A. Romberg.** (Am. Acad., Proc. 57. pp. 377–387, June, 1922.)—An account of an experiment designed as a crucial test of the correctness of the temperature variation curve of the specific heat of water. The results of some of the best researches on the subject show great discrepancies at the higher temperatures, hence the desirability of such a test. The paper contains a description, with diagrams, of the apparatus employed, but the treatment of the problem is mainly mathematical and not suitable for abstraction. The net result gives the value $1 \cdot 0040 \pm 0 \cdot 0005$ for the ratio of the specific heat of water at 73° C. to that at 20° C. This agrees more closely with the results of Dieterici, Barnes, and Callendar than with those of Regnault, Lüdin, Bousfield, and Jaeger and von Steinwehr.

E. F.

2303. *Measurement of Heat Conductivity of Liquids, Insulators, and Metals.* **M. Jakob.** (Zeit. Vereines deutsch. Ing. 66. pp. 688–693, July 8, 1922. From the Reichsanstalt.)—A form of apparatus is described which has been employed in measuring the conductivity of liquids, badly conducting materials, and metals, the range of conductivity being from $\lambda = 0 \cdot 00032$ to $\lambda = 0 \cdot 49$ cal. cm.$^{-1}$ s^{-1} grad.$^{-1}$. The material to be tested was in the form of a thin sheet, thick plate, or cylinder, according to the nature of its conductivity. The specimen was heated from above by an electrical heater, and cooled below by a stream of liquid. The temperatures were measured by thermocouples, which were carefully compared with each other. The loss of heat by radiation and convection was greatly reduced by inverting a Dewar flask over the upper portion of the apparatus. Sketches are given showing the details of the apparatus for liquids, badly conducting, and metallic conductors. In the steady state, if W = energy supplied by the heater $W = F(t_1 - t_2)\lambda/l + V$, where F is the cross-section, l the thickness or length of specimen, t_1, t_2 the temperatures of upper and lower surfaces, V the energy lost to surroundings. The author splits V into five parts, and shows how to obtain their values. It was found that $t_1 - t_2$ varied with the material from 4° to 12° C. The values obtained for λ in the case of toluol are much higher than those of H. F. Weber and Goldschmidt. A positive temperature coefficient is obtained for water, while Lees obtained a negative one. In the case of metals, Al and Al alloys (including silumin) and nickel steel (30 % nickel) were examined. Nickel steel was found to have a conductivity of only 0·03 c.g.s. units. The effect of various heat treatments of the steel on its conductivity was determined. The value of λ obtained by the author for a nickel-steel supplied by Krupp did not agree with the value obtained by Honda. The author points out the practical importance of a knowledge of the conductivity of metals and alloys in order that the best material may be selected for such parts of machines as cylinders, pistons, etc.; he also draws attention to practical problems in which a knowledge of the conductivity of liquids is of importance. T. B.

2304. *Isothermals of Nitrogen, Oxygen, and Helium.* **L. Holborn** and **J. Otto.** (Zeits. f. Physik, 10. 6. pp. 367–376, 1922. From the Reichsanstalt.)—The determination of the isothermals for air, argon, hydrogen, and helium has been previously described [Abs. 92 (1916) and 481 (1921)], and the present paper reports an extension of the investigation. The same apparatus was employed, and in the case of He the observations have been continued to include pressures ranging from 50 to 100 atmospheres. N and O were investigated at temperatures 0°, 50°, and 100° C., the range of pressures being up to 100 atmospheres. The results, which are given in a series of tables, may be expressed in the form

$$pv = \mathrm{A} + \mathrm{B}p + \mathrm{C}p^2.$$

If p is expressed in metres of mercury and the unit of volume be taken as that occupied by the gas at 0° C. under a pressure of one metre of mercury, the values of the constants are as shown in the accompanying Table.

		A.	$B10^3$.	$C10^6$.
Nitrogen	0°	1·00057	−0·58100	4·76327
	50°	1·18368	−0·02500	3·80616
	100°	1·36682	+0·36057	3·15102
Oxygen	0°	1·00130	−1·30143	0·46452
	50°	1·18456	−0·63543	0·27755
	100°	1·36782	−0·20357	0·22571
Helium	0°	0·99930	+0·69543	—
	50°	1·18223	+0·68887	—
	100°	1·36518	+0·66804	—

The mean thermal expansion coefficients and pressure coefficients are also calculated and tabulated. Assuming the composition of air to be

75·5 % N and 24·5 % O, the values of *pv* for air are calculated from the data for O and N. These values are in fair agreement with those obtained by direct observation on air in the paper previously cited. L. L.

2305. *On the Kinetic Theory of an Isolated Saturated Vapour Phase.* **E. Wertheimer.** (Zeits. f. Physik, 10. 4. pp. 252–255, 1922.)—The author considers the physical state of three portions of vapour, *a, b, c,* separated from the liquid state, *d,* all at the same temperature, which can be diagrammatically represented thus:

a. supersaturated vapour	*b.* saturated vapour	*c.* unsaturated vapour
	d. liquid	

Each of these three states is stable provided there is no passage of heat to the surroundings and no change of volume. Under these conditions, for a very small change of state in each case, $\delta s = 0$, where s = entropy . . (1), and the three states, *a, b, c,* differ only in the specific volume (v). But besides these quantitative differences there is the practical difference between *b* and either *a* or *c*. If the states *a, b, c* are put in connection with *d*, then *b* undergoes no change, but *a* and *c* do undergo change, and become the same as *b*. Hence $v = f(\mathrm{T})$ only . . (2), for *b*, but for *a* and *c*, v depends on another variable besides T. The state required by (2) can be obtained without the help of the liquid phase: for we can compress the vapour at constant temperature t (below the critical temperature), taking care that the state is always stable, so that no supersaturated vapour exists, then $v = f(p, \mathrm{T})$, but as T is constant $v = f(p)$. We know from experiment that finally p becomes constant, and then $p = \phi(\mathrm{T})$ where ϕ does not depend on v, and hence we return to (2). The equations (1) and (2) can also be applied to a two-phase system. If we wish to specify kinetically the condition for saturation of a single phase, we must turn to the kinetic interpretation of equation (2). If we put the energy of motion of the molecules per mol as $\mathrm{L} = 3/2\mathrm{RT}$, we get in place of equation (2) the purely mechanical one $\mathrm{L} = f(v)$ . . (3), and we must deduce the properties of a saturated vapour from this equation. We must, for example, explain why the energy of motion cannot decrease below a minimum value depending on the number of particles per unit volume, when the particles are uniformly distributed and exist in stable equilibrium. It appears as if we require an unknown law (which has been needed by Planck), i.e. the law which the molecules obey in virtue of their mutual fields of force and collisions. The determination of this law does not any longer appear hopeless. T. B.

2306. *The Entropy of Elements and the Periodic System.* **W. Herz.** (Zeits. Elektrochem. 28. pp. 258–259, June 1, 1922.)—Some years ago Lewis and Gibson calculated the entropies of a series of elements [see Abs. 177 (1918)], and discussed their relationship to the third thermodynamic law. The present author now examines these entropy values in connection with the position of the elements in the periodic system. He finds that the entropy of the elements so arranged decreases from the permanent gases to a minimum, and increases again to high values at the halogens. Elements which are readily vaporised have very high values. In the element families, the entropy increases with the atomic weight, so long as positive or indifferent elements are considered. With negative elements the entropy values are greater for the smaller atomic weights. H. H. Ho.

2307. *Calculation of the Constant c_2 of Planck's Formula and Determination of the Mean Wave-length of Residual Rays on the Assumption of Planck's Isochromatics.* **G. Michel.** (Zeits. f. Physik, 9. 5. pp. 285–299, 1922.)—Values of c_2 obtained by different investigators are given. From the equation $E_2/E_1 = (e^{\frac{c_2}{\lambda T_1}} - 1)/(e^{\frac{c_2}{\lambda T_2}} - 1)$, when $T_1 = \frac{1}{2}T_2$ we get $E_2/E_1 = e^{\frac{c_2}{\lambda T_2}} + 1$; or putting $E_2/E_1 - 1 = A$, we have $c_2 = \lambda T_2 \log_e A$ . . (1). This formula enables us to calculate c_2 for a given λ and T_2 and a known deflection ratio. On the other hand, knowing c_2 we can calculate λ, which may be the mean wave-length of residual rays.

The remainder of the paper is divided into two parts; the first discusses the methods used and results obtained in order to obtain the value of c_2, and quotes those obtained by H. Rubens and the author [see Abs. 157 (1922)]. The mean value obtained is 14,720, which gives for h the value $6 \cdot 521 \,.\, 10^{-27}$. The second part deals with the determination of the mean wave-length of residual rays. It is pointed out that the expression $c_2 = \lambda T_2 \log_e A$ is not suitable for long wave-lengths, since the "Klappen correction" was excessively large. We can, however, overcome this difficulty by employing the equation $(E_2 - E_1)/E_3 - E_1 = q$, which can be solved for λ by giving suitable values to T_1, T_2, T_3. It has been found more advantageous, however, to plot q against λ and to calculate the mean wave-length of the residual rays. A diagram of the arrangement of the black body, microradiometer, reflectors, and absorbers used is given. Six kinds of residual rays were employed, i.e. residual rays from fluorite filtered through 6 mm. of sylvite; from fluorite, aragonite, NH_4Br, and sylvite, through 0·4 mm. of quartz, and from rock salt through 0·8 mm. of quartz. The results obtained for the mean wave-length of the residual rays agree well with those obtained by Rubens by the use of the interferometer. We may hence conclude that Planck's formula is true for wave-lengths 100 times greater than that of red light. T. B.

SOUND.

2308. *Nature of Speech and its Interpretation.* **H. Fletcher.** (Frank. Inst., J. 193. pp. 729–747, June, 1922.)—To make a quantitative study of speech it is necessary to obtain the speech sounds at varying degrees of loudness and with definitely known amounts of distortion. This was extremely difficult by acoustic means. But, owing to recent developments, it is now possible to produce the equivalent of these changes by electrical means. For this purpose a telephone system was constructed which reproduced speech with practically no distortion. It was arranged so that by means of distortionless attenuators the volume of reproduced speech could be varied through a very wide range, and so that by introducing various kinds of electrical apparatus the transmitted speech wave could be distorted in definitely known ways. A method was developed for measuring quantitatively the ability of the ear to interpret the transmitted speech sounds under different conditions of distortion and loudness. By choosing these conditions properly, considerable information has been gained concerning both speech and hearing. This indirect method of attack has a distinct advantage for telephone practice, in that it measures directly the thing of most interest, namely, the degrading effect upon telephone conversation of introducing electrical distortion into the transmission circuit. But the value of the results is not limited to this field.

Briefly stated, the method consists in pronouncing detached speech sounds into the transmitting end of the system and having observers write the sounds which they hear at the receiving end. The comparison of the called sounds with those observed shows the number and kind of errors made. The percentage of correctly received sounds out of the total spoken sounds is called the articulation of the system.

It is found, as the result of many experiments with various observers, that the intensity of undistorted speech which is received by the ear can be varied from a hundred times greater to a million times smaller than the initial speech intensity without noticeably affecting its interpretation. The intensity must be reduced to one-ten-billionth (probably 10^{-10} is meant) of that initial speech intensity to reach the threshold of audibility for the average ear. Also it is found that any apparatus designed to reproduce speech and preserve all its characteristic qualities must transmit frequencies from 100 to above 5000 per second with approximately the same efficiency. Although most of the energy in speech is carried by frequencies below a thousand, the essential characteristics which determine its interpretation are carried mostly by frequencies above a thousand. In ordinary conversation the sounds *th*, *f*, and *v* are the most difficult to hear, and are responsible for half the mistakes of interpretation. The characteristics of these sounds are carried principally by the very high frequencies. The paper is illustrated by diagrams and many tables and graphs. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

2309. *Problems Relating to a Thin Plane Annulus.* **J. W. Nicholson.** (Roy. Soc., Proc. 101. pp. 195–210, June 1, 1922.)—The problems in connection with a thin annulus cut from a plane sheet of metal are of importance both in electrostatics and in hydrodynamics. Their mathematical solution is very difficult, and only first approximations have hitherto been obtained. The author obtains higher approximations sufficiently accurate for practical work. It is shown that the actual difference of the radii of the circles bounding the annulus is of comparatively small significance in finding such magnitudes as the electrical capacity of the annulus. The method adopted—namely, treating the annulus as a special case of an elliptic anchor ring—can be readily used to get the solution to a higher degree of accuracy, if desired. The surface density of a free distribution of electricity on a thin annulus whose radii are $c - a$ and $c + a$ respectively is given by

$$\sigma = \frac{\sigma_0 a}{\{(c + a - r)(r - c + a)\}^{\frac{1}{2}}}\left\{1 - \frac{r - c}{2c} + \frac{5}{16}\frac{(r - c)^2}{c^2}\right\}$$

where σ_0 is the surface density on the main circle where $r = c$, and σ is the surface density on the circle of radius r. The author proves that the capacity of the annulus is

$$2\pi c\left(1 - \frac{3a^2}{32c^2}\right)\Big/\left\{\left(1 - \frac{a}{2c} + \frac{a^2}{4c^2}\right)\log\frac{16c}{a} + \frac{a}{2c}\left(1 - \frac{5a}{2c}\right)\right\}$$

The following table shows how the capacity varies with the aperture:

a/c.	(Capacity)/$2\pi c$.
0·05	0·177
0·1	0·205
0·15	0·227
0·2	0·247
0·25	0·263
0·3	0·283

The presence of an inner edge much increases the capacity as the laws of electrical distribution require that the surface density becomes large there. It is pointed out that a certain annulus has a maximum capacity for a given mean radius. In this case the aperture is very small. The mathematical results given apply also to the corresponding problems in hydrodynamics, the conduction of heat, the conduction of electricity, and the inductance of circuits. A. R.

DISCHARGE AND OSCILLATIONS.

2310. *Free Paths of Electrons in Argon.* **J. S. Townsend and V. A. Bailey.** (Phil. Mag. 43. pp. 1127–1128, June, 1922.)—In a previous paper [see Abs. 1685 (1922)] the authors give the results of experiments on the motion of electrons in pure argon and show that the mean free path of the electrons is much greater in argon than in nitrogen or hydrogen, and that the loss of energy of an electron due to a collision is much less in argon than in these two gases, for velocities of agitation of the electrons between $8 \cdot 5 \times 10^7$ and $14 + 10^7$ cm. per second. Within this range of velocities the free path in argon increases as the velocity of agitation diminishes. The authors now investigate the variation of free path at very low velocities agitation, by adding hydrogen to the argon. The mean free path of argon is thus found in terms of the mean free path of hydrogen. The experiments show that the reduction of velocity in hydrogen by adding argon having four times the pressure of the hydrogen is too small to permit of an accurate determination of the mean free path in argon. Further experiments are contemplated. A. B. W.

2311. *Measurement of High Potentials. Sparking Potential of Gases.* **K. Keil.** (Zeits. f. Physik, 10. 5. pp. 308–316, 1922.)—A simple method is described for measuring the high potentials used in determining the sparking potentials in different gases. In parallel with the spark gap (connected to the terminals of an influence machine) is joined a circuit consisting of a high resistance in series with a galvanometer. A current flows in this circuit proportional to the potential applied across the spark gap, and by suitable adjustment can be made to measure this potential. In the apparatus used the resistance consisted of glycerine contained in a glass tube, and had a value of 5×10^8 ohm. A choking coil was used on each side of the galvanometer, which was shunted by a condenser and variable resistance. One terminal of the Töpler machine used was earthed. Measurements were made of the sparking potentials in air, H_2, N_2, O_2, CO_2, CO, NO, C_2H_2, etc. The results show that the ratio of the sparking potential in these gases to that in air is proportional to the relative energy required for ionisation by electrons. A. W.

2312. *Discharge through Rarefied Gases.* **A. Steichen.** (Phys. Zeits. 23. pp. 229–232, June 1, 1922.)—The discharge tubes used were about 60 cm. long and were divided into two portions by a perforated glass partition. The phenomena observed when the electrodes were connected to the two terminals of a Wimshurst machine are described in detail. With the discharging knobs of the machine wide apart the discharge tube was illuminated fairly brightly, but if then the discharging knobs were brought closer together and a spark passed, the tube was illuminated very brightly at every spark. On stopping the machine and bringing the discharging knobs together the illumination of the tube continued for, in some cases, as much as seven minutes. The phenomena observed are discussed, and the conclusion is reached that the effects are due to the discharge tube acting as a condenser, the gas in the two portions of the tube serving as the condenser plates and the perforated glass partition as the dielectric. A number of other experiments were carried out to confirm this view. A. W.

2313. *Positive Column of the Discontinuous Discharge of the Second Kind.* **G. Valle.** (N. Cimento, 23. pp. 343–392, May–June, 1922.)—In continuation of previous work [see Abs. 1136 (1921)] the author shows that the positive column of the discharge of the second species which is formed at the commencement of every partial discharge may indicate the nature of the electric field existing at the moment when the tube begins to glow and the point at which the potential gradient is a minimum. J. W. T. W.

2314. *Polarity of the Electric Arc.* **L. Dunoyer and P. Toulon.** (Comptes Rendus, 174. pp. 1615–1617, June 19, 1922.)—Considers the apparent anomaly in the Garbarini arc, where the anode is at a high temperature while the kathode is cooled, and in the mercury rectifier where it is possible to heat the anode without interfering with the rectifying action. The author concludes that if the electrodes are not in contact no arc passes if the cold electrode is the kathode; an arc passes, however, if it is the anode. If, however, there is contact between the electrodes the arc always passes, with continuous current, because the contact only allows current to pass at a limited number of isolated points, which therefore become very hot locally. These points may be too small to produce any visible incandescence, but their temperature is sufficiently high to allow the emission of electrons. J. W. T. W.

2315. *Chains of Magnetically-Coupled Circuits.* **B. van der Pol.** (Electrician, 89. p. 33, July 14, 1922.)—The problem of finding the frequencies of a system of n equal and equally coupled circuits is dealt with in this article. The general equation is solved by a method of substitution. The free periods w are given by the formula:

$$w^2 = w_0^2/[1 + 2k \cos (l\pi/n + 1)],$$

where $w_0^2 = 1/LC$, $k = M/L$ is the common coefficient of coupling, and l must be made equal to 1, 2, 3 . n. E. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2316. *Thermoelectric or Photoelectric Reactions in Molybdenite.* (Am. I.E.E., J. 41. p. 398, June, 1922.)—T. W. Case recently raised the question as to whether the photonegative reaction observed with certain samples of molybdenite is caused by an electric current, saying that he had found molybdenite to be light active, i.e. it generates an electric current without an impressed potential. The photonegative action of molybdenite was accordingly reinvestigated, and it was found that though a small electric current is generated without any impressed potential, it is too small to affect the photonegative reaction previously observed. The tests were made by connecting the molybdenite with a sensitive galvanometer and exposing different parts of the sample to an equal energy spectrum. It was found that, on exposure to radiation, a small electric current is developed, which is a function of the wave-length of the light stimulus and of the thickness of the sample. The maximum effect is produced by wave-lengths of 0·7 to 0·8 μ, and no effect was produced by wave-lengths greater than 1 μ. The effect may be "photopositive" or "photonegative," depending on the wave-length of the radiation stimulus, just as observed when there is an impressed potential. It is, therefore, an interesting question whether all photoelectrical reactions in solids are an amplification of the effects produced without an e.m.f. The generation of an electric current directly from exposure of a substance to light (*e.g.*, cuprous oxide in copper formate; probably photochemical) is not an entirely new phenomenon. Whether molybdenite belongs to this class remains to be determined. For in spite of this apparent selectivity of the reaction to wave-length of the light stimulus (which can be explained on the basis of the variation in spectral transmission) some of the effects produced by thermal conduction, as applying heat directly by touching the molybdenite with a hot wire, make the phenomenon appear to be thermoelectric, resulting from inhomogeneity, and perhaps impurities. A. W.

2317. *Actinometer with Electrodes of Mercury Coated with Compounds of the Halogens or Sulphur.* **G. Athanasiu.** (Comptes Rendus, 175. pp. 214–217, July 24, 1922.)—E. Becquerel (1839) found that light can produce a potential difference when it falls on one of two electrodes in the same electrolyte. He worked chiefly with chloride, bromide, and iodide of silver. The same effect has been found with other metallic compounds, but pure metals give very feeble currents. The illuminated electrode almost always becomes positive with respect to the dark one. In the present investigation thin films of Hg_2I_2, Hg_2Br_2, Hg_2Cl_2, Hg_2F_2, and HgS were formed on the surface of electrodes of pure mercury, by chemical methods or by electrolysis. The most sensitive films were got with bromine-water, and better still with a dilute solution of iodine in alcohol. Vessels having the H form of standard cells were used, and the illuminated surface was about 5 cm.^{2}. There were two or three cm. of electrolyte above the electrodes; and the light passed through this vertically. A potential difference of $6 \cdot 6 \times 10^{-6}$ could be measured with a dead beat, moving coil galvanometer. As the e.m.f. varies rapidly with the time a zero method cannot be employed. After a reading the actinometer is replaced by a potentiometer and adjustments are made to find the e.m.f. which gives the same deflection. The cell is kept short-circuited for some time before measurements are made, to bring the electrodes into an identical electric condition. The heating effect of the light was found by experiment to be negligible. The e.m.f. was + 5865 microvolts after 48 hours, with an Hg_2I_2 film, formed on the mercury by the action of an alcoholic solution of iodine; and varied for other halogen compounds down to + 29 microvolts with Hg_2Br_2, produced by electrolysis of a solution of KBr. With an HgS film it was − 198 microvolts, half an hour after the formation of the film, and − 577 microvolts after two hours. Pure mercury shows no effect. The effects observed seem due, in part at least, to momentary, reversible, chemical modifications of the electrodes. The following reversible modification is known to take place under the influence of light: $Hg_2Cl_2 = HgCl_2, Hg$. H. N. A.

2318. *On the Relation between Photoelectric Phenomena and the Surface Tension of Mercury.* **J. G. Popesco.** (Comptes Rendus, 175. pp. 259–261, July 31, 1922.)—By assuming the existence of an electric double layer at the surface of any insulated conductor *in vacuo*, Freubel defines the surface tension as being equal to the available energy per unit of surface of the electronic layer which forms the negative part of this double electric layer. Every variation of this energy, therefore, should involve a variation of surface tension, and photoelectric phenomena offer the possibility of so varying the available surface energy as to establish a relationship between electronic emission and surface tension. For experimental purposes, the Klages method, as used for the study of the photoelectric emission of mercury, has been adopted, and is described at length. A table of results is given which demonstrates the existence of a connection between the photoelectric phenomenon and surface tension. H. H. Ho.

2319. *High-Frequency Resistance of Inductance Coils.* **G. Breit.** (Bureau of Standards, Bull. 17. pp. 568–587 [Sci. Papers, No. 430], 1922.)—At sufficiently high frequencies difficulty is encountered in discussing the resistance of a coil owing to (1) the skin effect and (2) the capacity effect. The capacity effect is dealt with in the present paper, and it is believed that the modifications introduced in this treatment by the skin effect are only minor. The capacity effect results in the non-uniform distribution of current in the coil considered. It appears to be necessary to define the resistance of a coil not for the coil as a whole, but only for a particular point of the coil. Imagine the wire cut at that point, the two faces of the cut separated by a very small gap and an e.m.f. inserted in that gap. Call the e.m.f. e and the current i, e being the real part of $Ee^{j\omega t}$ and i the real part of $Ie^{j\omega t}$. The impedance of the coil, together with the circuit connected across its terminals, with reference to the point at which the gap was made, is defined, as usual by the equation $z = E/I$. The real part of the impedance is termed the resistance, and the coefficient of j in the imaginary part is called the reactance. It may be shown that the resistance R thus defined is such that i^2R is the power lost in the coil, where i and R are measured at the point where the e.m.f. is applied. To simplify the treatment the coil is assumed to be a non-dissipative system. The properties of non-dissipative dynamical systems are reviewed and the results are then applied to coils. It is shown that the current distribution for resonance is independent of the distribution of e.m.f.'s, and that it is the same as if the system were non-dissipative, provided the conductivity of the material is high. Further, a resistance inserted at some point in the coil does not affect the current distribution. It merely cuts down the current in the same ratio at all points of the coil. Hence, if the coil has been brought into resonance at some frequency by adjusting the condenser in parallel with it, it will still be in resonance when a resistance is inserted at any point. This suggests a method of measuring R at any point by the resistance-variation method described for the case of the coil terminal in Bureau of Standards Circular 74, pp. 180–185. A formula is then derived for the current at one point of a coil due to an e.m.f. at a different point, and the results have been checked experimentally. A calculation is then made of the resistance of a coil on the assumption that the effect on it of skin effect is known. This formula has also been verified experimentally. A. W.

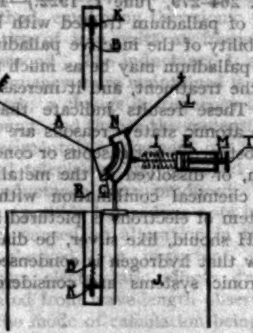
2320. *Oscillation Circuits for the Determination of Dielectric Constants at Radio Frequencies.* **P. A. Cooper.** (Nature, 109. p. 814, June 24, 1922.)—In the arrangement described simple transmitting and receiving circuits are combined in such a way that oscillations of two different frequencies can be generated, although both the valves used are fed from the same filament and anode batteries. The condenser containing the material under investigation is included in the transmitting circuit, the valve for which can only oscillate and not rectify. The latter fact is of importance, since rectification is necessarily accompanied by distortion of wave form. The valve of the receiving circuit can both oscillate and rectify. These results are achieved by making the potentials of the two grids with respect to earth the same, but making the potentials with respect to the valve filaments different in the two circuits. The filaments of the valves are connected in series, and in this way troubles due to variations of frequency arising from varying filament heating are to a very great extent reduced. A circuit diagram is given. A. W.

2321. *Prototype Standards of the International Ohm.* **P. Janet.** (Comptes Rendus, 175. pp. 77–80, July 10, 1922.)—In England in 1903, at the National Physical Laboratory, six prototype standards of the ohm were recognised. Germany had, between 1890 and 1893, at the Physikalische Technische Reichsanstalt, five mercurial resistances; three of 1 ohm, one of 0·5 ohm, and one of 2 ohms. France possessed, in 1884, four mercurial standards of the ohm having almost exactly the value of the legal ohm. In 1910 representatives of the various laboratories met at Washington to make a study in common of the silver voltameter for an International ampere and, as a provisional standard of the ohm, the Washington ohm, the mean of the standards at the National Physical Laboratory and the Reichsanstalt was taken. Since this time most of the different laboratories have constructed mercurial prototypes of the International ohm. In 1913 England had fifteen, of which five were for Japan. In the United States, the Bureau of Standards also had a certain number of mercurial ohms, only differing by seven-millionths from the new English prototypes. In France R. Benoit spent considerable time and trouble to obtain as exactly as possible the value of the International ohm. Most elaborate precautions were taken, particularly during the war, to protect the tubes from all possible harm, and very accurate results indeed were obtained. T. C. H.

2322. *Development of Maxwell's Capacity Bridge.* **V. A. Bailey.** (Phil. Mag. 43. pp. 1107–1112, June, 1922.)—It is shown that in a general network of electric conductors, in which there is a galvanometer, together with one or more sources of e.m.f. and a condenser having one set of plates permanently connected to a junction, while the other set is alternately connected *n* times per sec. to one or other of a pair of junctions, when the variables are adjusted so that there is no galvanometer deflection, the permanently-connected plates of the condenser may be connected to *any* point in the network without disturbing the zero galvanometer deflection. The theorem is extended to include inductances in the network, and is illustrated by its application to Maxwell's bridge method for determining the capacity of a condenser in electromagnetic units. J. S. G. T.

2323. *Electrostatic Wattmeter.* **G. L. Addenbrooke.** (Electrician, 88. pp. 466–469, April 21, 1922.)—After an historical review of the quadrant electrometer and its application to the measurement of alternating currents and dielectric losses, the author describes recent improvements by means of which he obtains a sensitiveness of over 400 mm. at 2 metres with 100 volts on the needle and 0·1 volt between the quadrants. This instrument has a good control of the electrical and mechanical zeros. The use of the instrument at 0·1 per cent. power factor is considered, and it is shown that an accuracy up to 5 per cent. is attainable, using a good wave form and avoiding errors due to surface leakages from the leads and operating switches. It gives results of value on capacities as low as 1/1000 microfarad, working on a 100-volt circuit at 50 periods. The mathematical theory of the instrument is given, and its application to modern precision measurements (as, for example, the measurement of induction) is described. J. W. T. W.

2324. *Electrometer for Radiology.* **B. Szilard.** (Comptes Rendus, 174. pp. 1618–1620, June 19, 1922.)—Describes a new form of electrometer shown in the Fig. A bronze strip R carries the needle A and a metal sector C, which moves between two metal quadrants N. These are discharged from the ionisation chamber J. I, E, M, and T form a small automatic friction machine for charging N, while L is an artificial leak for adjusting A to any desired zero position. A microscope is provided for reading the position of A on the scale, and it is claimed that



the instrument will measure a current of 6×10^{-13} amps., which gives a movement of 1 division per sec. The advantage of portability is also claimed for the instrument. J. W. T. W.

ALTERNATING CURRENTS AND MAGNETISM.

2325. *Polar Curves for Alternating Currents.* **W. Geyger.** (Elekt. Zeits. 43. p. 764, June 1, 1922.)—This paper describes briefly the author's apparatus for obtaining or exhibiting polar curves of alternating currents [Abs. 1002 (1922)], and gives polar diagrams obtained with the apparatus of (1) an approximately sine-formed alternating current, and (2) a pulsating direct current. [See also Abs. 204 (1922).] A. W.

2326. *Permeability of an Artificial Magnet.* **A. Goldhammer.** (Phys. Zeits. 23. pp. 247–251, June 15, 1922.)—The magnet was made of steel balls held in place in a glass tube by ebonite discs. The tube was over 25 cm. long and 2 cm. in diameter; it contained 159 steel balls 6·4 mm. in diameter arranged in threes alternately ∴ and ∵ with suitably hollowed ebonite discs between. The magnetic properties of this composite body were examined in a magnetising solenoid by the ballistic method, and after applying corrections the mean value of μ was 2·40 for fields from 19 to 341 gauss; μ increased slightly with increase of field. Using a mean value 70 for permeability of steel, Poisson's formula for the permeability of a composite body gave $\mu = 2 \cdot 38$, which agrees with the experimental value. G. E. A.

2327. *Strength of Nickel in Relation to Magnetic Behaviour.* **W. Del Regno.** (Accad. Lincei, Atti. 31. i. pp. 465–467, June 3, 1922.)—It has been found that at the critical temperature at which nickel loses its magnetism, variations of electrical resistance, thermo-electric power, and emissive power takes place. The tensile strength is found to fall gradually to a value of about 48·5 kg. per sq. mm. at 400° C., and thereafter more quickly to 35·8 at 500° C. The rate of fall in the last 100° is nearly 9 times that in the first 400°. This temperature of 400° is very close to that at which discontinuities have been found in the rigidity-temperature curve and in the emissive power. J. W. T. W.

2328. *Magnetism and Atomic Structure.* II. **A. E. Oxley.** (Roy. Soc., Proc. 101. pp. 264–279, June 1, 1922.)—In the present paper the magnetic properties of palladium treated with hydrogen are examined; the specific susceptibility of the inactive palladium is 64·6 × 10^{-7}, and that of the charged palladium may be as much as 75 per cent. less than this, depending on the treatment, and it increases again as the occluded hydrogen escapes. These results indicate that the hydrogen is not occluded in the free atomic state; reasons are also given for supposing that the occluded substance is not gaseous or condensed molecular hydrogen in solid solution, or dissolved in the metal. The hydrogen is considered to form a chemical combination with the palladium in the form PdH; the system of electrons is pictured as similar to that in the silver atom, and PdH should, like silver, be diamagnetic. The facts do not support the view that hydrogen is condensed as a liquid within the metal. Other electronic systems are considered in the light of the results. G. E. A.

2329. *Influence of Electrically Conducting Material within the Earth on Various Phenomena of Terrestrial Magnetism.* **S. Chapman** and **T. T. Whitehead.** (Cambridge Phil. Soc., Trans. 22. pp. 463–482, June, 1922.)—Part I contains the mathematical theory of induction in a spherically symmetrical earth; particularly the case of induction in a conducting shell enclosing a conducting core separated from it by a non-conducting shell. The outer conducting shell, which is designed to represent the oceans and moist land strata near the earth's surface, has not figured in previous mathematical treatments in which the earth has been represented simply by a conducting core surrounded by a non-conducting shell, the thickness of which was estimated by S. Chapman from the diurnal magnetic variation as 250 km., and the conductivity of the core as 3·6 × 10^{-13} c.g.s. units, the magnetic permeability of the core being assumed unity [see Abs. 949 (1919)]. Part II contains applications to problems of terrestrial magnetism, and it is found that the effect of a moist land shell is almost negligible, but that even a thin oceanic shell produces induction effects comparable with those of the supposed core. There should thus be differences between the diurnal magnetic variations at oceanic and continental stations. The remainder of Part II is summarised by the author as follows:—Some related problems are considered, in particular, the magnitude and type of the earth currents flowing near the earth's surface, both those which accompany the ordinary diurnal magnetic variations, and the larger currents observed when the earth's field is varying rapidly and irregularly. Again, the main symmetrical part of the field of a magnetic storm is examined, and it is shown that the relation between the horizontal and vertical components is compatible with the existence of a core, the conductivity of which is of the order inferred from the study of the diurnal variation. Finally, the opportunity is taken of seeing how far the original estimate of the conductivity (κ) and the size of the core would be modified if the unlikely assumption were made that the permeability (μ) differs appreciably from unity. It appears that, consistently with the observed data, a wide range of values is permissible for κ provided that μ varies almost proportionately (and this without much change in the thickness of the outer non-conducting shell). M. A. G.

2330. *Measurement of Magnetic Susceptibilities at High Frequencies.* **M. H. Belz.** (Cambridge Phil. Soc., Proc. 21. pp. 52–55, May, 1922.)—The heterodyne beat method, employing thermionic valves, is applied to measure the susceptibilities of iron salts at frequencies ranging from 3×10^5 to 4×10^5 per second. The inductance L of a coil in a circuit in which oscillations of frequency n are maintained is changed by inserting the specimen inside the coil; a change in frequency is caused from which the change in L can be found, and thence the susceptibility. Two circuits were employed in the experimental arrangement, one an ordinary oscillating circuit with amplifier and telephone, and a second oscillating circuit in which the changes of inductance were produced. The two sets were loosely coupled to give an audible heterodyne note in the telephone, and the change of inductance caused an alteration in this note from which the susceptibility was derived. An important precaution was the shielding of the coil from electrostatic effects due to the specimen. Frequencies were calculated from wave-length observations made with a Townsend wave-meter, the mode of calculation being based on the usual formula, $n = 1/2\pi\sqrt{(LC)}$. The results found for mass susceptibilities were: $FeCl_3$ solution, $90 \cdot 7 \times 10^{-6}$; $FeSO_4 . 7H_2O$ crystals and powder $74 \cdot 0 \times 10^{-6}$; $FeSO_4(NH_4)_2SO_4 . 6H_2O$ crystals, $41 \cdot 1 \times 10^{-6}$. These agree with the values found by balance and low-frequency methods, a result to be expected, as it is only at very high frequencies when the period of oscillation is comparable with the "time of relaxation" of a molecule that a change in the permeability would occur. Such changes have been observed in iron and nickel by Arkadiev [see Abs. 649 (1922), 619 (1920)]. G. E. A.

2331. *Reversible Permeability of Iron.* **W. Kaufmann.** (Zeits. techn. Physik, 3. 6. pp. 198–199, 1922.)—The results obtained by Erhardt [Abs. 706 (1918)] and by Gans [Abs. 1160 (1921)] are not in agreement, the former having employed, according to Gans, field variations of too great a magnitude. Experiments are here described with extremely small field variations, a three-valve amplifier being used to increase the sensitivity of the measurements. In this way field amplitudes of less than 0·001 gauss could be employed. Curves are given for hard steel and soft iron, and it appears that the behaviour of what Gans [Abs. 1848 (1908)] calls the reversible permeability is not nearly so simple as the experiments of Gans show. For soft iron the "null point" curve has a similar form to that obtained by Gans, but for hard steel there is a considerable difference. A. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2332. *Isotope Ratio of New Zealand Boron.* **A. D. Monro.** (Chem. Soc., J. 121. pp. 986–988, June, 1922.)—For boron prepared from the borax of hot springs in New Zealand the isotope ratio is identical with that of European boron to within one part in 60. T. H. P.

2333. *Identification of a Missing Element.* **E. Rutherford.** (Nature, 109. p. 781, June 17, 1922.)—An interesting note relating to the recent discovery by Dauvillier and Urbain [see Abs. Nos. 2086 and 2087 (1922)] of the identity of celtium with the missing element of atomic number 72 on the Moseley classification. A. B. W.

2334. *Properties of Hydrogen Desorbed from Platinum and Palladium.* **P. Anderson.** (Chem. Soc., J. 121. pp. 1153–1161, June, 1922.)—Hydrogen desorbed from platinised asbestos or from palladium black retains to some extent its activity. The desorbed gas is found to be ionised slightly but not sufficiently to account for the increased activity, and evidence of the presence of triatomic molecules is not forthcoming. It is possible that the internal energy of the hydrogen molecules themselves is increased as a result of absorption and subsequent desorption. T. H. P.

2335. *Season-Cracking in Condenser Tubes.* **H. Moore** and **S. Beckinsale.** (Engineering, 113. pp. 337–340, March 17, 1922. Abstract of paper read before the Inst. of Metals, March, 1922.)—This is an abstract of a communication from the Research Department at Woolwich and may be regarded as a continuation of the work referred to in Abstract 666 (1922). W. R. C.

2336. *Atomic Weight of Mercury from Different Sources.* **J. N. Brönsted** and **G. Hevesy.** (Nature, 109. p. 780, June 17, 1922.)—The successful accomplishment of separating isotopes of mercury [see Abs. 1735 (1922)] suggested an investigation to determine the extent to which samples of mercury from different sources might show the same atomic weight, i.e. the same density, which is to be expected only if the various minerals contain the isotopes in the same ratio. Mercury obtained from minerals from 10 different sources was distilled with iron *in vacuo* and the densities measured by the method previously described. No difference in density greater than 2–6 in a million (within limits of experimental error) was observed, thus proving, with great accuracy, that the isotopic composition of mercury of terrestrial origin is the same. A. B. W.

2337. *Crystallisation of Amorphous Tellurium.* **A. Damiens.** (Comptes Rendus, 174. pp. 1548–1550, June 12, 1922.)—The thermal relationships between amorphous and crystalline Te are studied experimentally and discussed in reference to the two current contradictory theories of the nature of amorphous substances. The employment of a specially designed solution of Br in hydrochloric acid for the attack on crystallised Te enables the author to show that specimens of crystalline Te prepared according to various methods are thermally identical and confirms the irreversible relation: Te (amorph) = Te (cryst.) + 2·63 Cal. Te thus ceases to be exceptional, and the "metastable" theory is supported. A. B. C. L.

2338. *Occurrence of a Blue Constituent in High-Strength Manganese Bronze.* **E. H. Dix, Jr.** (Am. Inst. Mining Eng., Trans. [16 pp.] May, 1922.)—When the hardening elements (aluminium, tin, iron, and manganese) are added to the 60–40 copper-zinc alloy in sufficient quantities to produce a high-strength manganese bronze, a third constituent appears in the alpha-beta prime complex, which has a characteristic clear blue colour. The characteristics of this constituent are investigated.
W. R. C.

2339. *Physical Properties of Cartridge Brass.* **C. Upthegrove** and **W. G. Harbert.** (Am. Inst. Mining Eng., Trans. [10 pp.] May, 1922.)—For low-temperature anneals, following reduction by rolling, the Brinell hardness of cartridge brass is appreciably influenced by the anneal previous to the rolling. This influence decreases as the degree of reduction in rolling is increased. For low-temperature anneals following reduction by rolling, the tensile strength and elongation are influenced, though to a lesser degree than the Brinell hardness, by the anneal previous to the rolling. For cartridge brass annealed at temperatures of 650° C., or above, after reduction by rolling, the Brinell hardness, tensile strength, and elongation are independent of the anneal previous to the rolling. AUTHORS.

2340. *Heat of Transformation of Austenite to Martensite and of Martensite to Pearlite.* **N. Yamada.** (Iron and Steel Inst., J. 105. pp. 409–427, 1922.)—A calorimeter was devised for measuring the heat evolution or absorption at high temperatures, in the vicinity of 400° C. With this calorimeter, the heat of dissolution of carbon in iron was measured for six kinds of carbon steels. The results confirm the correctness of Honda's theory of the A1 transformation.
W. R. C.

2341. *The Formation of Globular Pearlite.* **J. H. Whiteley.** (Engineering, 113. pp. 733–736, June 9, 1922. Iron and Steel Inst., J. 105. pp. 339–353; Disc. and Corres., 354–357, 1922.)—Cementite in steel does not dissolve completely at Ac_1 unless the steel be heated for a considerable time; the undissolved particles act, on cooling, as nuclei on to which the dissolved cementite is precipitated, and the pearlite so formed is globular and not lamellar. It was found that:—(1) Globular pearlite could be formed 20° C. higher than lamellar pearlite. (2) The *Ae* line (the true equilibrium position of the A1 transformation) was horizontal to within 5° C. (3) As the temperature falls below *Ae*, globular pearlite is formed with increasing velocity until the point Ar_1, at which lamellar pearlite can grow, is reached. (4) In hypereutectoid steels globular pearlite is not always produced. (5) In hypo-eutectoid steels the absence of globular pearlite indicates the absence of cementite nuclei from the solid solution.
J. L. H.

2342. *X-Ray Studies on the Crystal Structure of Steel.* **A. Westgren** and **G. Phragmén.** (Iron and Steel Inst., J. 105. pp. 241–262; Disc. and Corres., 263–273, 1922. Engineering, 113. pp. 630–634, May 19, 1922.)—X-ray photograms (according to Debye and Scherrer) of an iron wire, heated to 800°, 1100°, and 1425° C., have shown that the iron within the so-called β- and δ-ranges has a body-centred cubic structure and within the γ-range a face-centred cubic structure. The strange fact is thus proved, that the transformation that takes place at 900° C. (A3) is reversed at 1400° C. (A4). The γ-iron lattice of austenite steels is enlarged by the dissolved carbon. A steel with 1·98 % carbon has been found to have a somewhat larger lattice when quenched from 1100° C. than when quenched from 1000° C. Also the α-iron lattice in martensite seems to be influenced by the carbon present. The ranges of homogeneous α-iron lattice in martensite have proved to be extremely small. It has been stated that a steel with 0·80 % carbon, quenched in water from 760° C., is on the verge of being totally amorphous. Crystal data for cementite are given. W. R. C.

2343. *Magnesium-Cadmium Alloys.* **L. Guillet.** (Rev. de Mét. 19, pp. 359–365, June, 1922.)—The equilibrium diagram of the Mg-Cd alloys is discussed and the physical properties are predicted from the diagram and compared with the actual properties. The following properties are described:—(1) Variation of hardness at ordinary temperatures and after quenching, or quenched and annealed. (2) Variation of malleability with temperature. (3) Variation of electrical conductivity after quenching, followed by annealing or not. (4) Variation of density. (5) Microstructure. The following conclusions are drawn:—1. The structure and properties are unaltered by quenching or annealing. 2. The β and β' solutions are malleable at all temperatures. 3. The β' solution is of practical interest. J. L. H.

2344. *Recalescence in Antimony.* **E. Karrer.** (Optical Soc. America, J. 6. pp. 369–373, June, 1922.)—A globule of antimony was placed in a small furnace and in contact with a small thin-walled quartz tube into which a thermocouple was inserted. A photometer was placed a short distance above the surface of the antimony. Curves were thus constructed giving the relation between temperature and brightness as the temperature fell from about 700° C. At a temperature of 580° C. the brightness suddenly jumps to a high value and remains so for an appreciable time, while the temperature also rises. The phenomenon was incidentally observed while antimony and other metals were melted to make alloys for thermocouples. None of the other metals (tin, bismuth, cadmium) exhibit it. The recalescence takes place in an atmosphere of hydrogen or in vacuum in the same manner as in air. T. B.

2345. *Cerium Alloys.* **L. Guillet.** (Rev. de Mét. 19. pp. 352–358, June, 1922.)—A résumé of the constitution of certain cerium alloys. The following systems are dealt with:—Ce-Fe, Ce-Cu, Ce-Al, Ce-Mg, Ce-Bi, Ce-Sn, Ce-Si. It is pointed out that in these systems, (1) a very large number of intermetallic compounds is formed, (2) solid solutions are almost non-existent, (3) certain of the compounds undergo polymorphic transformations and, (4) in the Ce-Mg system the following curious reaction takes place: $3Ce + CeMg = Ce_4Mg$. J. L. H.

2346. *Limits for Flame Propagation in Vapour-Air Mixtures. I. Mixtures of Air and One Vapour at Ordinary Temperature and Pressure.* **A. G. White.** (Chem. Soc., J. 121. pp. 1244–1270, July, 1922.)—The previous work [Abs. 1445 (1920)] having shown changes in the upward and horizontal propagations of the flames with different tube diameters and different modes of firing in the case of ether, the author continues his experiments with vapour of ether, alcohols, acetone, benzene, toluene, carbon disulphide, etc., referring to previous workers. The experiments are made in glass tubes, 2·5 to 7·5 cm. in diameter, up to 1·5 m. long, closed by stopcocks at the ends, 4 mm. wide at the one end, 6 or 8 mm. wide at the other. One of these cocks is kept open during the experiment. Ignition is effected by various means, mostly by sparks from an induction coil; sometimes the flame would only travel with ignition by a hot platinum spiral or very small quantities of guncotton or cordite. The nature of the flame varies with the substance; the "cool" flames of ether and acetaldehyde gave the shortest flames, but they sent out long rays. The results obtained with tubes of various diameters differed very much less than those found by Eitner. Except in two cases, lower limits did not differ greatly with the direction of the propagation. Upper limits were greater for upward propagation than for propagation downward, except for cool flames. The lower limit for downward propagation was (roughly) inversely proportional to the net calorific value of the vapour; the upper limits followed a similar rule, being about 3½ times greater than the lower. The effective ignition temperatures would thus be approximately the same for various vapours and probably a good deal higher than those ordinarily determined. The loss of heat by radiation from the flame cannot be important. The heat given out by the burning flame is the driving power, but the ignition temperature is a function of the time during which the mixture is kept at that temperature. The amount of oxygen available for the combustion of a vapour in its limiting mixture bears a fairly constant ratio to the amount required for the perfect combustion of one molecule of the vapour.

H. B.

2347. *Contact Potential-Difference.* **E[ligio] Perucca.** (Accad. Lincei, Atti, 30. ii. pp. 54–57, July, 1921.)—The hypothesis, designed to explain Lippmann's electro-capillary phenomena, that the maximum superficial tension between mercury and, *e.g.*, acidulated water corresponds to a zero-true contact potential-difference between the two liquids, is falling into discredit. Pellat concluded from it that there would be no difference of potential between a metal and any solution of any of its salts; which appears inadmissible, and is wholly at variance with Nernst's theory. The reasons given in support of the hypothesis are (*a*) that a p.d. is due to a double layer, which reduces the superficial tension, so that if there be no double layer the superficial tension is at its maximum, and (*b*) when the mercury presents a maximum surface-tension, extension of the bounding surface does not give rise to a current. But reasons (*a*) and (*b*) do not apply when the double layer (1) is formed in a time shorter than what is necessary in order to set up a current and (2) is due to a transfer of charges across the thickness of the double layer itself, not to currents analogous to those of charges in a condenser. A double layer of thickness δ possessed of properties (1) and (2) will not reduce but will increase the surface tension, by an amount $2\pi \,.\, \delta \,.\, \sigma^2$. With such a double layer, a maximum surface-tension would be compatible with an effective p.d. But such a double layer may be identified with Nernst's double layer; and this clears up many difficulties.

A. D.

2348. *Constitution of Metallic Substances.* **C. A. Kraus.** (Am. Chem. Soc., J. 44. pp. 1216–1230, June, 1922.)—The constitution of substances cannot be derived from their properties in a condensed state with any degree of certainty, and in order to determine the constitutions of metallic substances their properties at low concentrations must be studied. At such concentrations the elementary metals are salt-like substances and metallic compounds should exhibit even more marked salt-like properties. In solutions of these compounds in liquid ammonia the more electronegative element is precipitated on the anode during electrolysis and thus functions as an anion; all but the strongly electropositive elements exhibit a negative as well as a positive valence. The normal anions of a metallic element form complex anions in presence of the element itself, these complex compounds being similar to the complex iodides and sulphides existing in aqueous solution; the property of forming complex anions is common to many metallic, as well as to non-metallic, elements. It has been shown that the complex telluride ion carries two charges, and the solution in ammonia contains the complex anions $TeTe^{--}$ and Te_3Te^{--}; it is assumed that the anions of the metals of the fifth and fourth groups carry three and four charges respectively.

Since selenium, tellurium, bismuth, antimony, arsenic, lead, and tin form complex anions in ammonia solution, it may be inferred that other metals, insoluble in ammonia, form similar complex anions; metallic compounds of this class are, therefore, virtually salts. The multiplicity of compounds derivable from any given pair of metallic elements is accounted for on the hypothesis that in their compounds the more electronegative elements form complex anions, metallic compounds being thus brought into line with present conceptions of atomic structure. Support for the salt-like structure of metallic compounds is furnished by their physical properties. Further, the energy effect accompanying the formation of metallic compounds is of the same order of magnitude as that observed in the formation of salts; as with the latter, this change becomes more pronounced as the one element becomes more electronegative with respect to the other.

Electropositive groups, such as the ammonium group, are virtually metals, although in most instances their stability in the free state is insufficient to allow of their isolation; the most stable groups do, however, possess sufficient stability when free to demonstrate their metallic properties. The property of metallicity is not an atomic one, but may be imported to non-metallic elements by combination with other non-metallic elements; the metallic state is due to the presence of uncombined negative electrons. The electrons which impart metallic properties to an element are those to which the chemical reactions of this element with other elements are due. The reaction between strongly electropositive and strongly electronegative elements or groups of elements consists essentially in combination of the negative electrons of the electropositive constituent with the atoms of the electronegative constituent. In the metal ammoniates of the type $Ca(NH_3)_6$, which are metallic substances, the negative electrons are not primarily concerned. T. H. P.

2349. *The Quinhydrone Electrode.* **E. Bülmann and H. Lund.** (Ann. de Chim. [ix] 16. pp. 321–340, Nov.–Dec., 1921.)—In a paper on the hydrogenation of quinhydrone E. B. (*ibid.*, 15. pp. 109–157, 1921) had shown that platinum foil dipped into a solution of an acid containing a little quinhydrone may be considered as a hydrogen electrode which, at 18°, has a hydrogen pressure of $10^{-24.4}$ atmo. This electrode is preferable to the platinum-black electrode in cases where the reducing action of hydrogen is to be eliminated, and it may serve for the determination of hydrogen-ion concentrations which are 0·1 molar. At higher concentrations the results are less concordant. The electrodes may, however, be used in cases where the electromotive reaction consists in the transformation of one solid body into another, and they are available for wide ranges of H-concentration. The construction of such electrodes—in glass vessel containing benzoquinone-quinhydrone or quinol-quinhydrone—is described. Their hydrogenation potentials are $V_{18}' = 0·7562$ or 0·6179 volt respectively. H. B.

2350. *The Salt Error of the Quinhydrone Electrode.* **S. P. L. Sörensen, M. Sörensen, and K. Linderström-Lang.** (Trav. Lab. Carlsberg, 14. 14. No. 14 [31 pp.], 1921. Chem. Soc. J., Abs. II, p. 111, Feb., 1922.)—In the presence of sodium chloride the quinhydrone electrode [see preceding Abs.] gives too small a potential, because the solubility of the quinhydrone is lowered. This can be overcome by saturating the salt solution with quinhydrone and with one of its constituents, *e.g.*, with quinol. The paper is theoretical and experimental. H. B.

2351. *Electric Conductivity of Salts and Salt Mixtures.* **A. Benrath and K. Drekopf.** (Zeits. phys. Chem. 99. pp. 57–70, Oct. 25, 1921.)—Continuation of previous work (*ibid.*, 94, 474, 1920) with salts of high melting-points (near 1000°). Porcelain vessels being unsuitable, the powdered salts are compressed into tabloids which are mounted between platinum foils packed with asbestos in an electric furnace. The salts and pairs of salts are: sulphates of K and Na, of K and Mg, of K and Li, sulphate of K and KF. The proportions are varied, and the temperature range extends for the first pair up to 1068°. While the point at which the eutectic appears is a well-defined conductivity point, the deduction of the conductivity-isothermal from the diagram of state is possible only to a limited extent. For pure salts and salts combining, the rule holds: $\log k = a + bT$. The formula does not hold generally for mixtures or mixed crystals, and Tubandt's formula: $\log K = c - d/T$ is not generally applicable. Other factors, especially viscosity, must be taken into consideration. H. B.

2352. *λ-V-Curves in Non-Aqueous Solutions of Binary Electrolytes.* **P. Walden.** (Zeits. phys. Chem. 100. pp. 512–531, 1922.)—The main sources of error to correct for in determining dissociation values from conductivity data are: (1) the large change in viscosity with changing concentration and, (2) in the Ostwald dilution formula the allowance for the space occupied by the solute itself in the solution whose volume should thus be given as $V - b$, where V is the vol. of solution containing a gramme molecule of solute and b the molecular volume of the solute. Other less determinable influences are the solvation of the ions and its change with varying concentration and the effect of the degree of dissociation on the dielectric constant and the change of ionic mobilities at high concentrations. In the case of a highly ionisable salt, such as KI in a solvent of low dielectric constant and low ionising power, such as SO_2, a typical anomalous property shown is an increase of λ_v with increasing dilution up to a value of $V = 1$ to 2 litres, a decrease from here up to a value of $V = 50$–$75l$, and then on further dilution, a progressive increase of λ_v without a limiting value being approached in the range of concentrations employed. The lower the dielectric constant of the solvent, the higher the dilution at which λ_v reaches a minimum and begins to rise. Expressing the chances of collision or the linear molecular concentration of molecules of solute as $1/\sqrt[3]{V_{min.}}$ at a point where a minimum value of λ_v is given, the following approximate relation is found to hold :—$\epsilon\sqrt[3]{V_{min.}}$ = const. = 38, where ϵ is the dielectric constant. It is found that the minimum points of the $\lambda - V_v$ curves represent the stage when the measured molecular weight is equal to the theoretical for single molecules. At other concentrations the following factors are at work :—Polymerisation of solute molecules and association of these and of single molecules with the molecules of the solvent to form micelles as is established by measurements of molecular weight and in certain cases, by observation of colour changes. The dissociation tendency of these groups is generally greater than those of the single molecules, and, in the case of KI, proceeds in steps by some such mechanism as :

$$K(K_{x-1}I_x) \rightleftarrows (K_xI_{x-1})I \rightleftarrows K^{\cdot} + (K_{x-1}I_x)' \rightleftarrows (K_xI_{x-1}) + I', \ldots \text{ etc.}$$

Additional factors are :—Solvolysis whereby, in certain cases, as with hydrolysis, the salt breaks down into its free acid and base, and tautomeric changes which occur, for instance, in the case of alkyl substituted ammonium halides. With water the value of $V_{min.}$ is found to be 0·07*l*. It is found that at any given dilution the following relation holds with all salts and solvents $x\epsilon\sqrt[3]{V}$ = const. = approx. 38), where *x* represents the degree of polymerisation or association of the solute molecules. **J. N. P.**

2353. *Anodic Behaviour of Metals in Non-Aqueous Solutions. III. Fe, Ni, Co, Cr in Ethyl Alcoholic Solutions of Nitrates.* **U. Sborgi and G. Cappon.** (N. Cimento, 23. pp. 303–331, May–June, 1922.)—When employed as anode in alcoholic solutions of calcium or ammonium nitrate, cobalt exhibits complete activity, dissolving as a divalent metal for current densities ranging from 0·03 to 3 amperes per sq. dm. and for temperatures between − 10° and 60°. Nickel exhibits passivity for all current densities at − 10° to 25°, and partial activity for high current densities at 60°. Iron is completely passive for all the temperatures and current densities employed. Chromium exhibits passivity phenomena similar to those observed with aqueous solutions, the attack being approximately sexavalent; in the alcoholic solutions, however, no chromate ions, but only chromic ions appear. With alcoholic solutions of calcium nitrate, a poorly conducting layer composed, at least partially, of calcium ethoxide, is formed at the kathode. In all the cases of partial or total passivity at 25°, oxygen is evolved at the anode in amount corresponding with about 7·5 per cent. of the current; acetaldehyde is also formed, but no trace of acetic acid. **T. H. P.**

2354. *Metallography of Electrolytic Metal Deposits on Kathodes of Aluminium and Chromium.* **S. Kyropoulos.** (Zeits. anorg. Chem. 119. pp. 299–304, Nov. 15, 1921.)—The electrolytic deposition marks a new phase which should not set in at a few points only, as it does in crystallisation, because all the atoms on the surface of the kathode may be expected to be ready to discharge electrons. Whether electrolytic deposition is uniform or discontinuous depends upon the state of the kathode surface, oxidation, passivity, etc. The author heats his Al-electrodes nearly to melting-point, polishes, and then etches them (in KOH; HCl with copper nitrate). The grain size of the aluminium is thus increased, and it is seen that Cu and Ag (from nitrate solution) are deposited on the grain boundaries, rarely on the crystallites, whilst Cr and Ni grow on the crystallite faces, but only at a few points of those faces. Higher current density (up to 0·5 amp./cm.^{2}) increases the number of points, very slightly in the case of Cu and Ag, very strongly in that of Ni. In cyanide solutions the deposition of copper is more uniform; when the Al-kathode is compressed after etching so as to produce gliding lines, the copper settles along these lines, and at higher densities, 0·8 amp./cm.^{2}, the copper deposit will appear uniform at a magnification of 1000; silver deposits, however, do not become uniform. The current densities stated are uncertain because the polished surface hardly conducts, so that the actual local densities must be much higher. The deposition is more uniform generally when it is accompanied by hydrogen liberation; but the copper deposits, even from cyanide, do not adhere well. That real oxidation of the kathode surface is not required to prevent deposition is shown by chromium kathodes, which when passive do not take deposits on crystallite faces even after etching. H. B.

2355. *Electrolytic Migration of Sodium through Glass.* **M. Pirani** and **E. Lax.** (Zeits. techn. Physik, 3. 6. pp. 232–235, 1922.)—Warburg (Ann. Phys. Chem. 11. 1890, p. 1) found that when a discharge tube containing impure nitrogen is immersed in sodium amalgam heated to 300° and a p.d. of 1000–1200 volts applied, metallic sodium soon begins to separate inside the tube and, under the influence of the discharge, unites with the residual oxygen and hydrogen present. The author employs similar means to get rid of the film of moisture from the inner surface of an evacuated bulb. The bulb, into which is sealed a spiral of tungsten wire is connected with a Volmer quartz mercury pump and freed completely from gases by heating the wire. It is then almost entirely immersed in fused sodium nitrate at about 450° and pumping continued until evolution of gas ceases. Heating of the wire to about 2100° is then followed by further liberation of gas, evidently owing to electronic decomposition of the residual film of moisture. Repetition of this procedure with continual pumping results in asymptotic diminution of the gas-formation. If, now, an e.m.f. of 200 volts is established between the sodium nitrate and the tungsten wire heated to 1700–1900°, a yellow glow appears inside the bulb, while metallic sodium mixed with a glistening deposit of various colours is observed on the neck of the bulb standing outside the nitrate. That the heated tungsten wire has been in contact with water vapour is shown by the occurrence of a slight coating of tungsten oxide over the whole surface of the bulb. The quantity of gas liberated during the removal of the moisture film in this way amounts to about 0·2–0·1 c.mm. per sq. cm. of glass surface, but this is only a rough estimate, since these gases rapidly unite with the sodium passing electrolytically through the wall of the bulb. A simple sodium-glow tube, based on these observations, is described. T. H. P.

2356. *Chemical and Electrochemical Behaviour of Salts of Lead Acids.* **G. Grube.** (Zeits. Elektrochem. 28. pp. 273–289, June 1, 1922.)—Two new methods for the preparation of alkali salts of plumbic acid are described, and the results are given of (1) a systematic investigation of the oxidation potentials of the processes, $Pb^{\cdot\cdot} + 2 \oplus \longrightarrow Pb^{\cdot\cdot\cdot\cdot}$ and

$PbO_2'' + 2{\cdot}OH' + 2\oplus \longrightarrow PbO_3'' + H_2O$, and (2) measurements of the potential of lead in solutions of alkali plumbite. The results obtained give the value − 0·203 volt for the normal potential of lead against alkali plumbate solution, and indicate that Pb_3O_4 must be regarded as the lead salt of ortho-plumbic acid and that the anions of meta-plumbic acid, PbO_3'', and ortho-plumbic acid, PbO_4'', are both present in highly alkaline solutions of plumbates. From the fact that the whole of the water is expelled from sodium plumbate, Na_2PbO_3, $3H_2O$, without decomposition of the salt, it is concluded that the three molecules of water consist of water of crystallisation and that sodium plumbate is a salt of meta-plumbic acid. T. H. P.

2357. *Electrolytic Preparation of Sodium Perborate.* **K. Arndt and E. Hantge.** (Zeits. Elektrochem. 28. pp. 263–273, June 1, 1922.)—Sodium perborate may be prepared electrolytically from an aqueous bath of sodium carbonate and borax. Reduction at the kathode may be reduced to a minimum by addition of a little chromate and a trace of turkey-red oil. A smooth platinum anode is necessary in order to obtain the high anodic potential requisite, and the best current density is 10–20 amps. per sq. cm. and the most suitable temperature 14–16°. The carbon dioxide lost during the electrolysis must be replaced, since otherwise the increased concentration of hydroxyl ions results in diminution of the current yield. The yield decreases with growth of the content of the per-salt in the solution, mainly on account of diminution of the anodic oxidation. The latter is decreased and the kathodic reduction increased by the presence of traces of platinum or iron in the liquid, the yield of the per-salt being consequently reduced; the injurious effect of iron is partially annulled by addition of cyanide. It is probable that a higher oxide of platinum, possibly PtO_3, acts as an intermediate product in the formation of sodium perborate. T. H. P.

2358. *Electrical Precipitation of Colloids.* **C. H. Hall.** (Am. Chem. Soc., J. 44. pp. 1246–1249, June, 1922.)—Experiments were carried out to ascertain if the application of a high potential will lead to the precipitation of a sol similarly to the phenomenon of smoke precipitation in the case of a gas. The medium used was a high-grade transformer oil and a suspension either of metal prepared by forming an arc between Al electrodes or else a precipitate of arsenic sulphide by dissolving arsenic iodide and passing in H_2S. The suspension was placed in a vertical tube of Pyrex glass 2 cm. in diam. and 35 cm. long, fitted with a Pt disc electrode at one end and an adjustable point electrode of Pt wire at the other end. A voltage of 2×10^5 was applied by an X-ray coil. For direct-currents three electrolytic interrupters and a condenser were employed in the primary circuit. In no case, either with direct or alternating current, was any sign of precipitation observed, nor was the subsequent rate of settling after treatment affected. It is calculated from Stokes' equation that the rate of precipitation of a sol would be 1/20000 of that for smoke for the same energy applied to the particles.

J. N. P.